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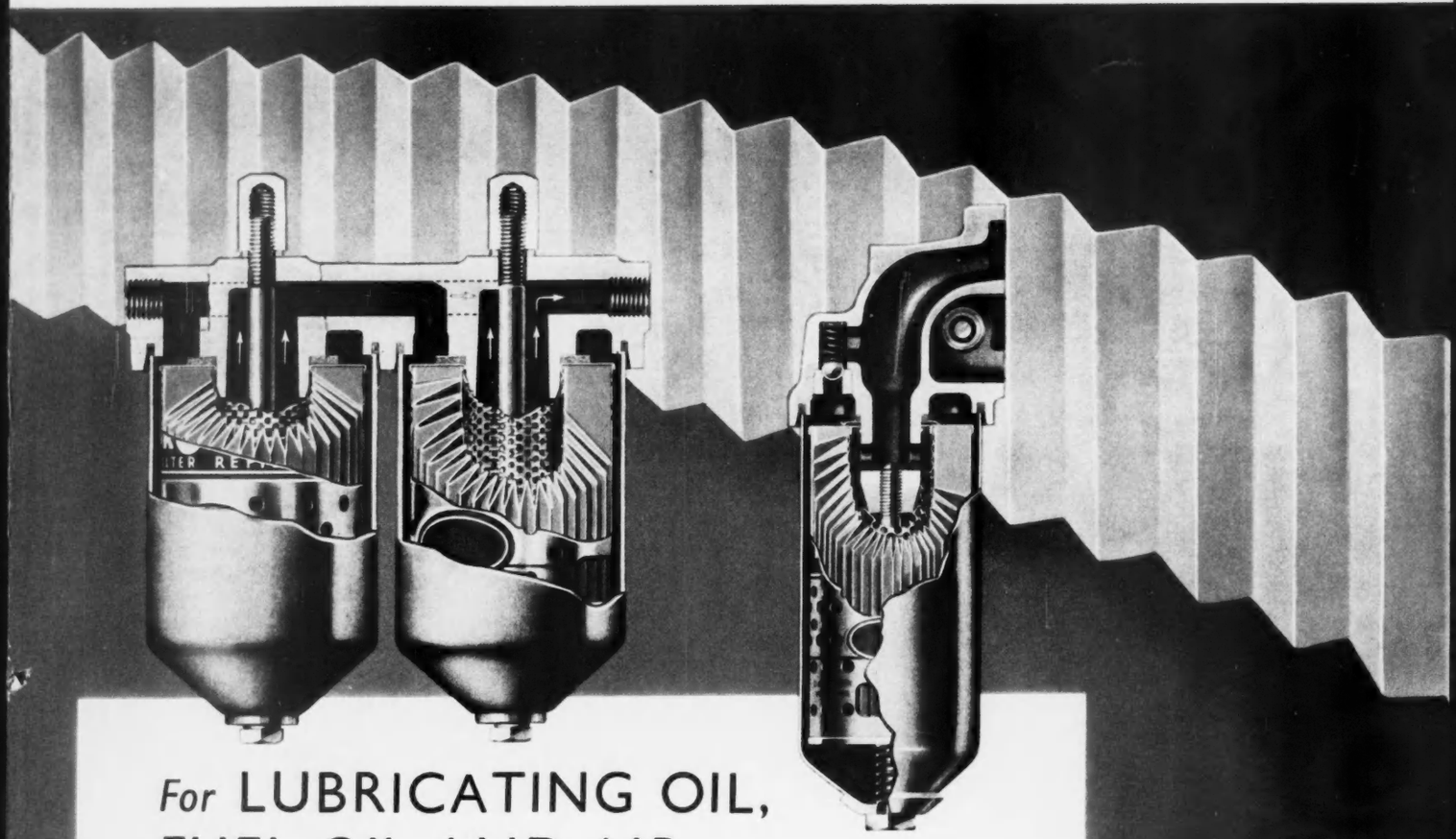

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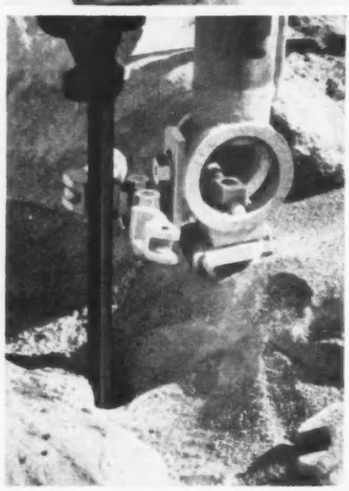

To secure the rig, bolt holes are drilled and anchor bolts and wedges placed in and driven tight. The bencher is placed on the heads of the anchor bolts and the feed is locked at the desired angle with chained wedges.
The operator can easily drill additional bolt holes while the rock drills already set up are running.

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THE ENGINEER

Established 1856

No. 5411 **OCTOBER 9, 1959** VOL. 208

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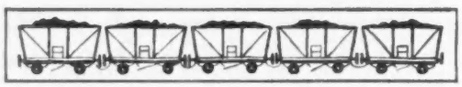

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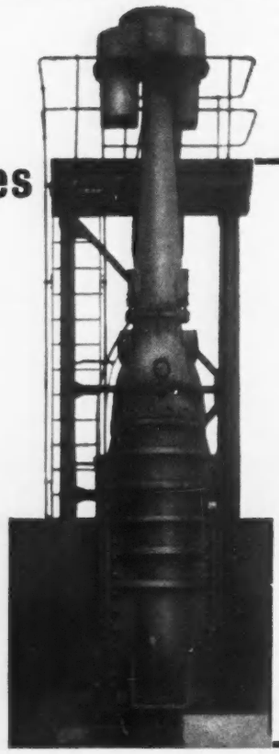

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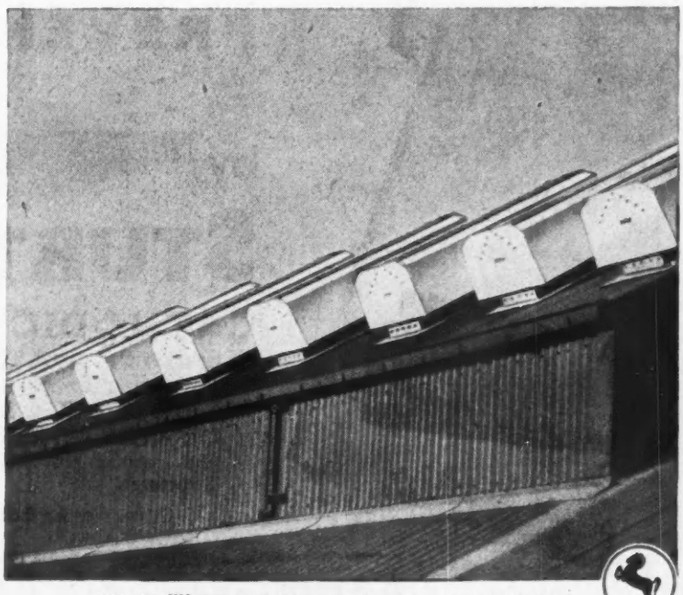

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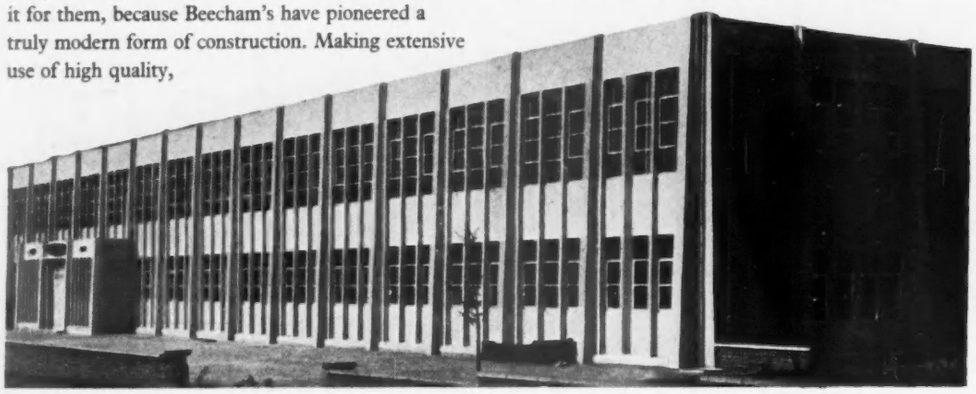

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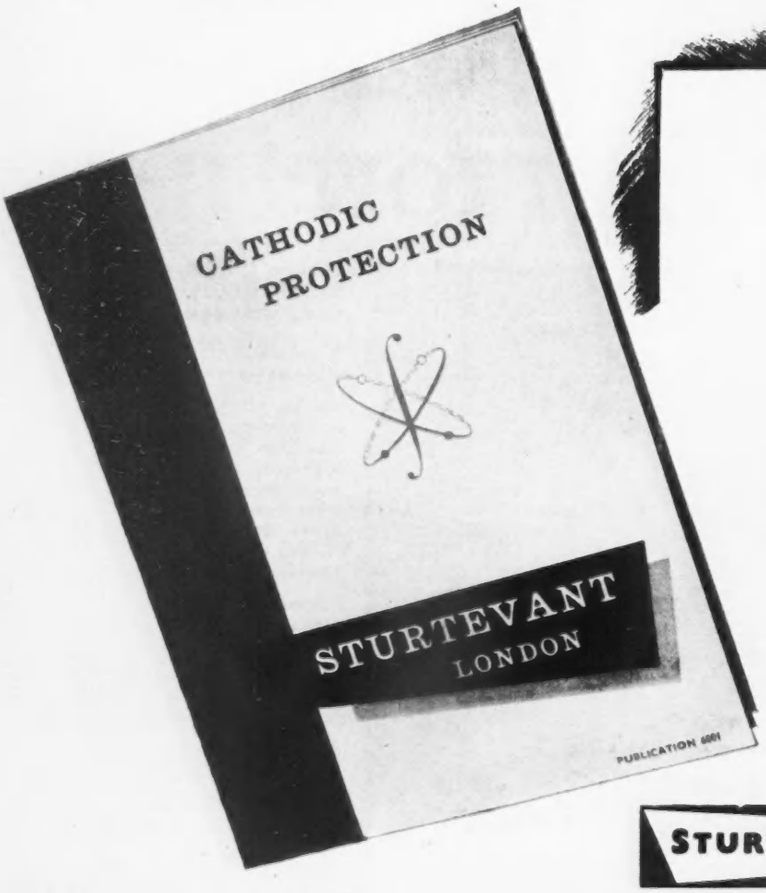

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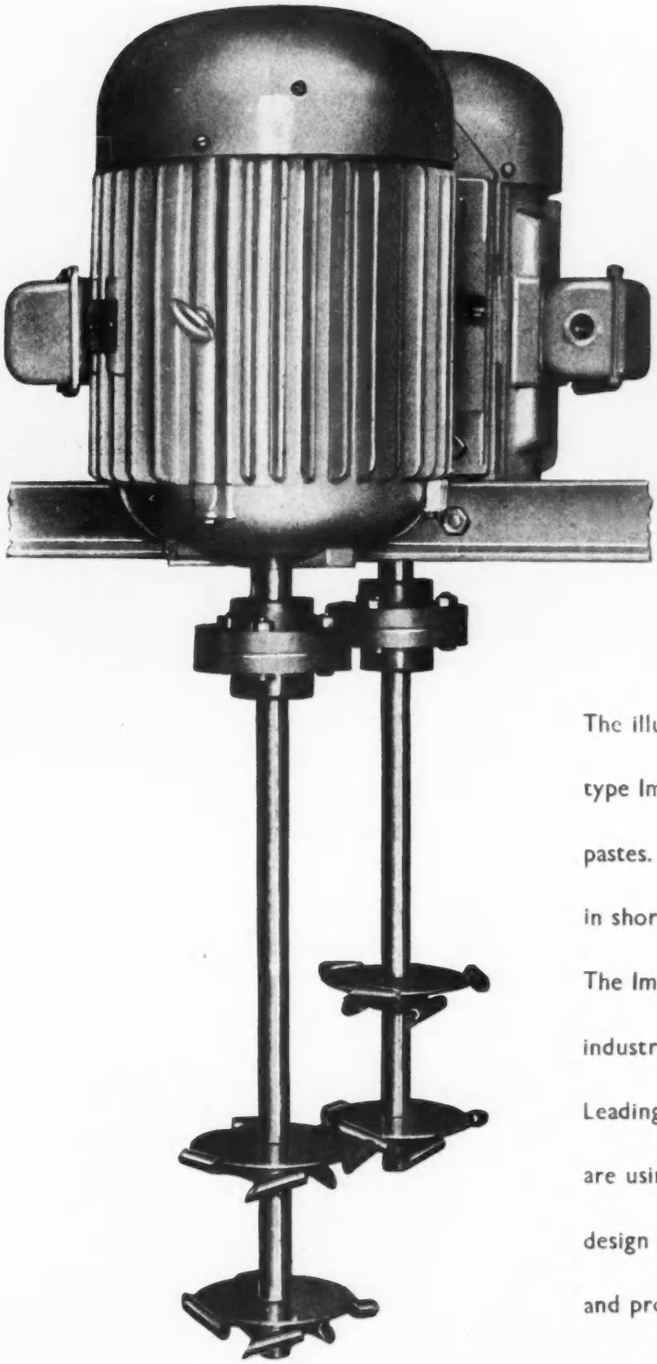

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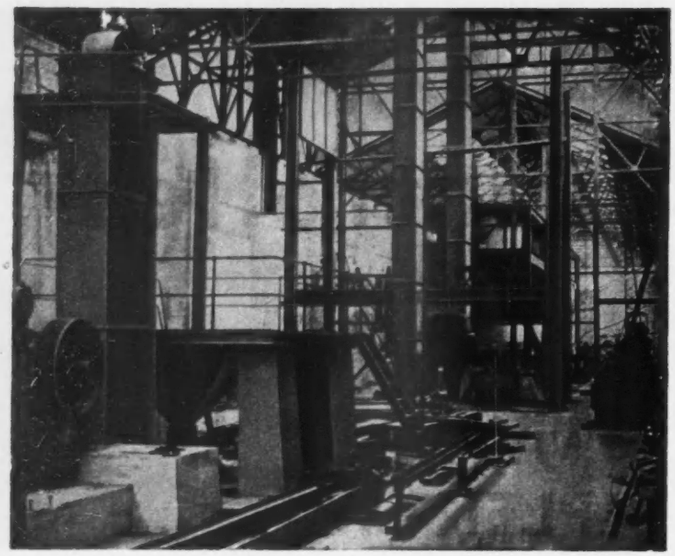

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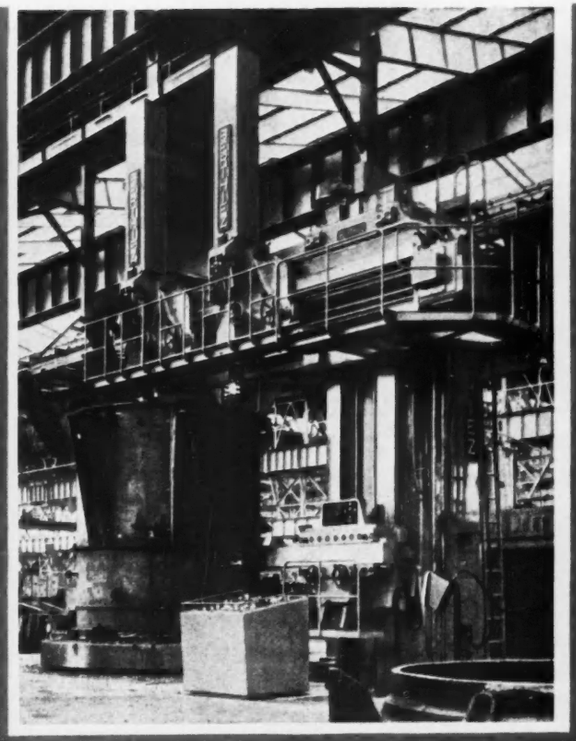

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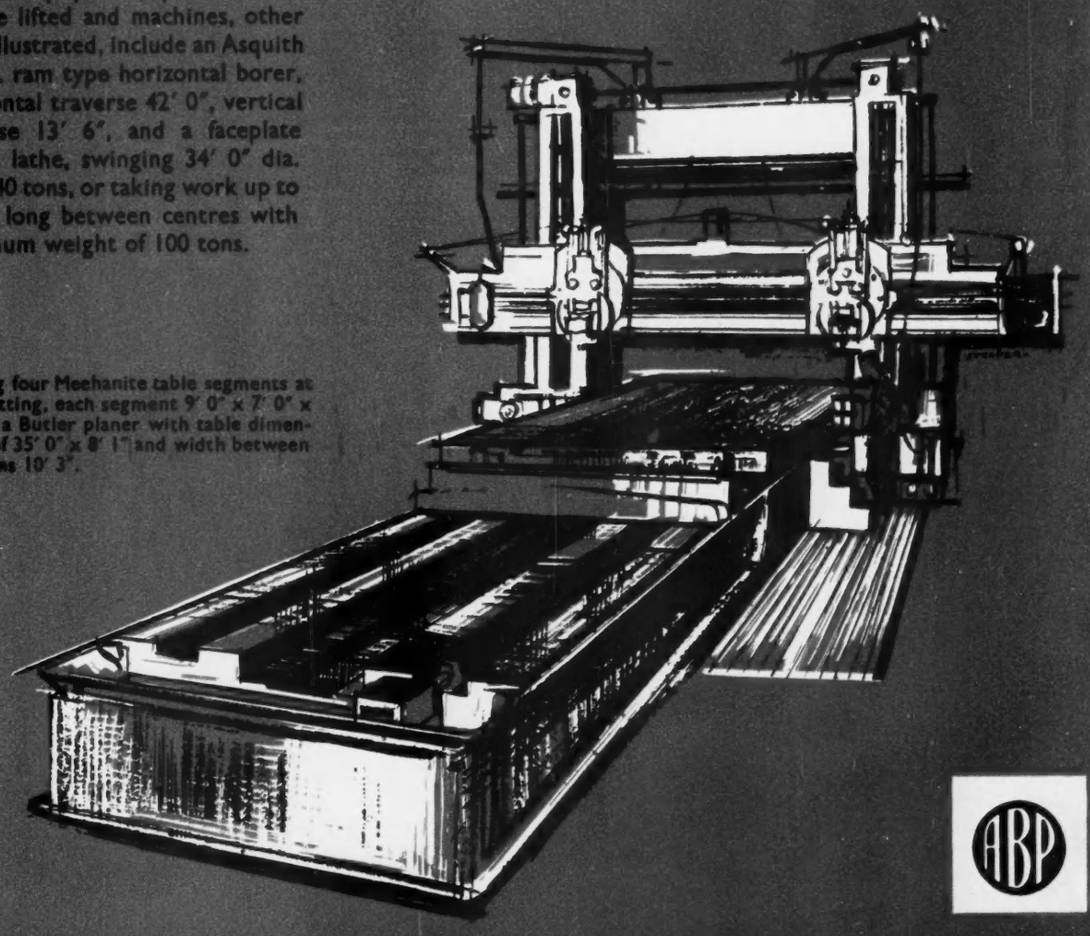

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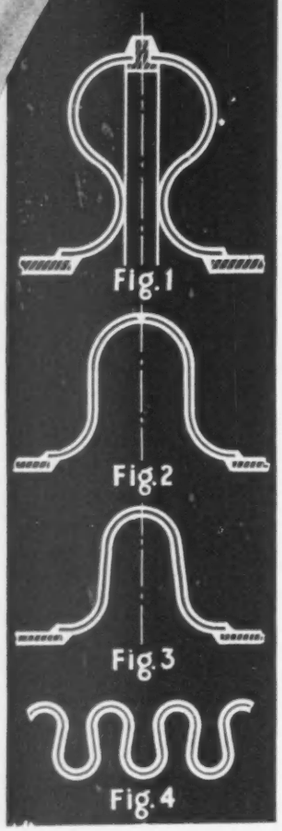

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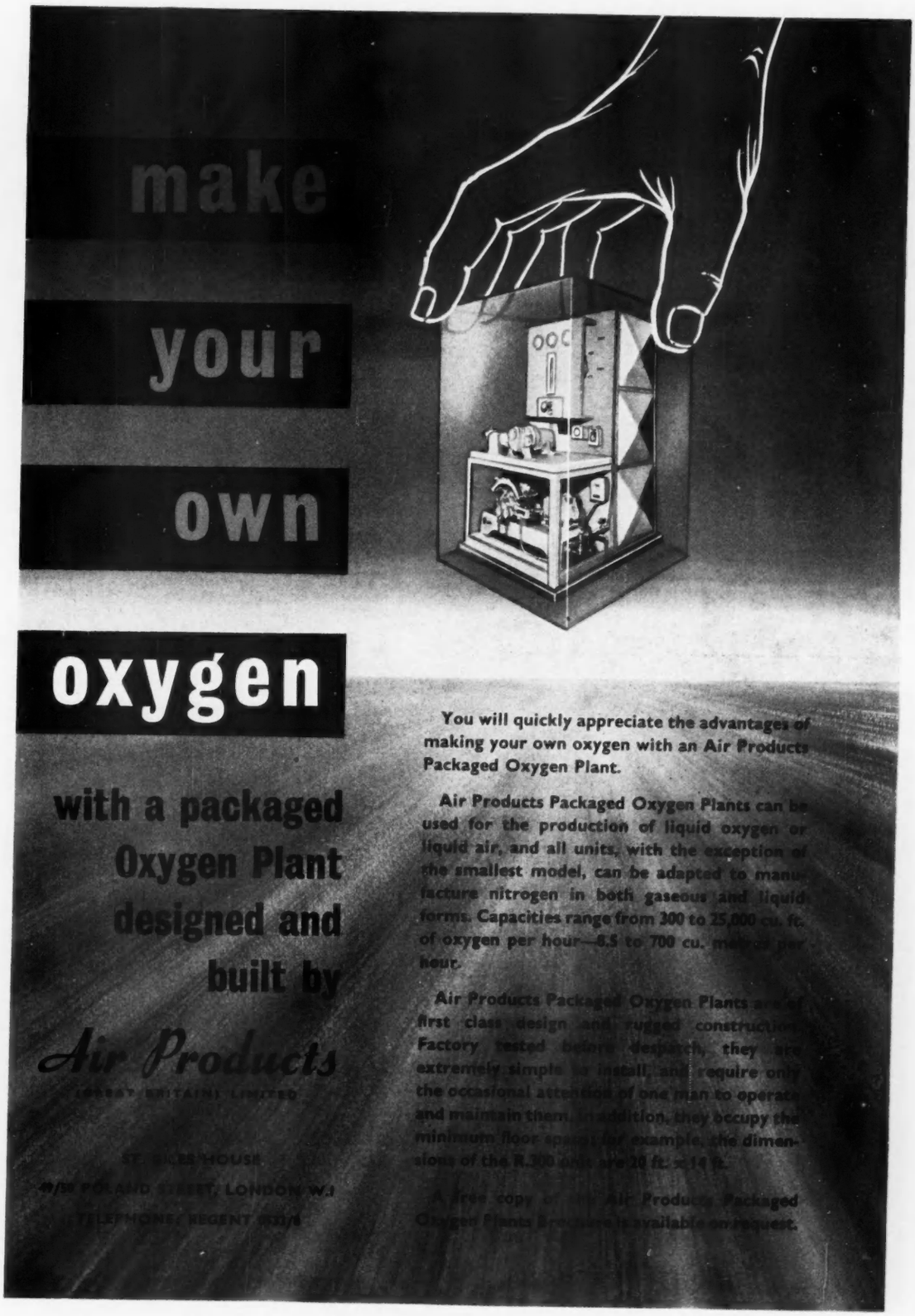
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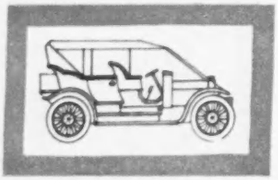

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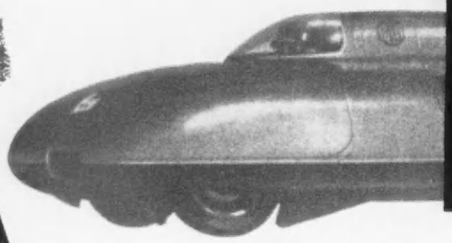

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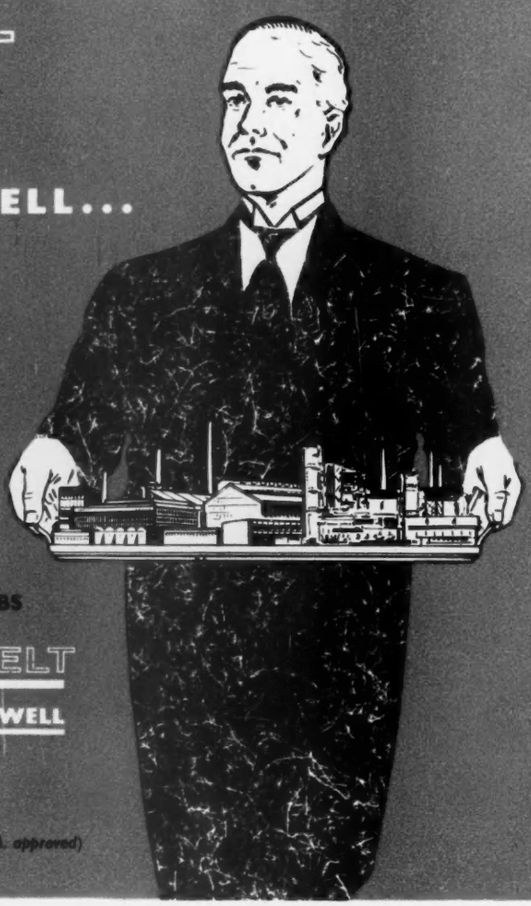

FELT DOES SO MANY JOBS

MEADOWFELT
REGISTERED
DOES SO MANY JOBS SO WELL

Telephone or drop a line to—
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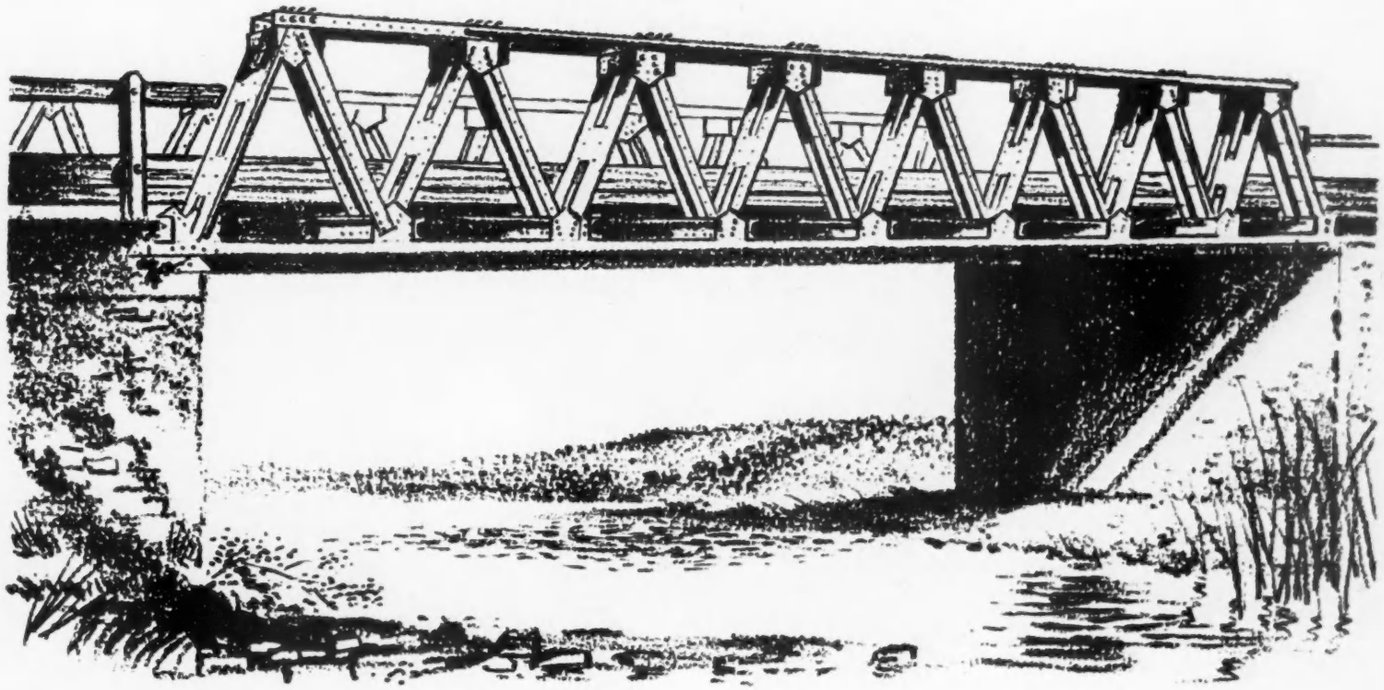

structural steelwork

by the BICC GROUP

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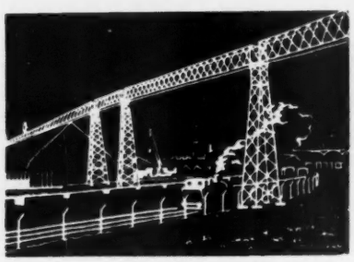
FABRICATION
GALVANISING
INSTALLATION

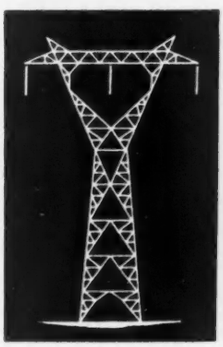
Callender-Hamilton road and railway bridges suitable for clear spans of up to 400-ft. are of unit construction and thousands of tons of the heavily galvanised standard components have been supplied to many parts of the world by members of the BICC Group.

BRITISH INSULATED CALLENDER'S CONSTRUCTION CO. LTD.
and
PAINTER BROS. LTD.

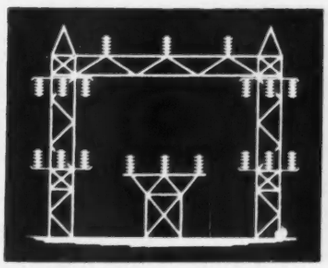
Specialists in the supply and erection of galvanised structural steelwork in all areas of the world.



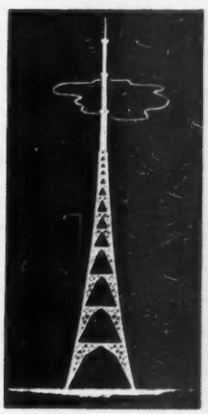
GANTRIES



OVERHEAD LINES



SUBSTATION STRUCTURES



MASTS & TOWERS

Contractors : BRITISH INSULATED CALLENDER'S CONSTRUCTION COMPANY LIMITED
30 LEICESTER SQUARE, LONDON W.C.2. CABLEGRAMS : BICALCON, LONDON. TELEPHONE : TRAFALGAR 7777
Steelwork : PAINTER BROTHERS LIMITED, HEREFORD. TELEPHONE : HEREFORD 3101

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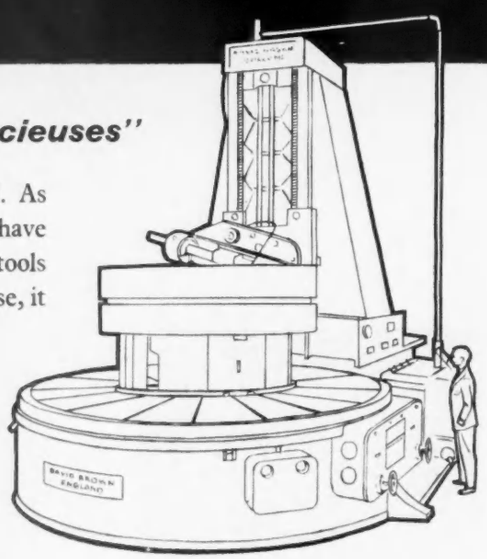
C

"Nous n'avons jamais entendu de vitesses aussi silencieuses"

Pardon our French, but that's what the customer said. He was speaking of turbine gears — cut on a David Brown Hobbing Machine, of course — which we had arranged for him to inspect aboard a ship . . . "we have never heard quieter running gears." Or words to that effect. After that the Entente couldn't have been more Cordiale and we secured his order in the face of intense German competition.

But it's not surprising really. For we at David Brown's believe that gears, like little boys, should be seen and not heard. As little as possible, anyway. And as we have been producing gear-cutting machine tools for a good deal longer than anyone else, it follows that gears cut on David Brown Hobbing Machines are in a class of their own — as regards quietness or anything else.

If your problem is one of quality gear production, for either 'batch' work or 'specials', drop us a line. The impatient can telephone.



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THE DAVID BROWN CORPORATION (SALES) LIMITED

MACHINE TOOL DIVISION, BRITANNIA WORKS, SHERBORNE STREET, MANCHESTER, 3. TELEPHONE BLACKFRIARS 4711

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. . . . . made in carbon and alloy steels, weldless and flash-butt welded. Also Rings produced from the "NIMONIC" alloys: Titanium, light alloys or copper bearing materials.

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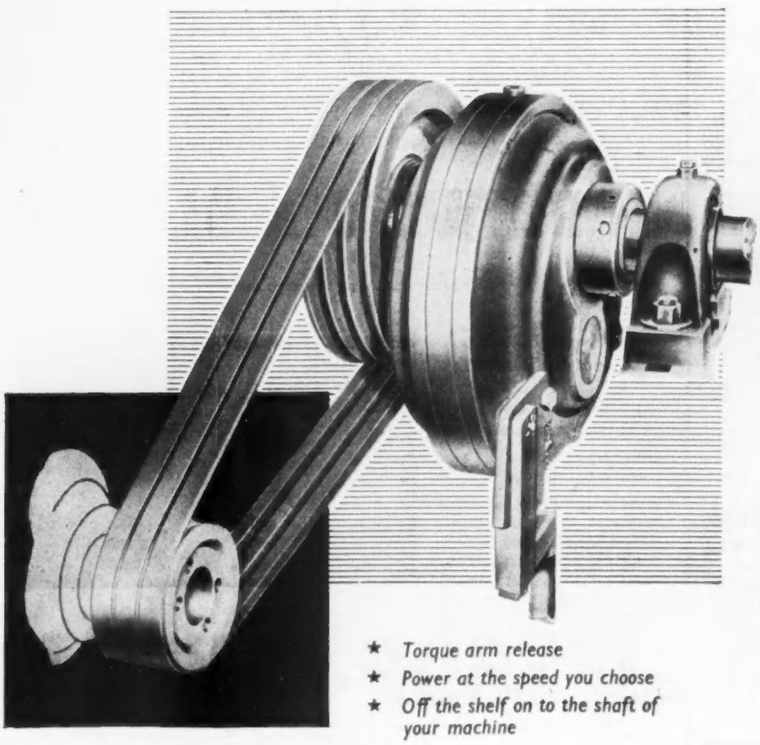

★ Torque arm release
★ Power at the speed you choose
★ Off the shelf on to the shaft of your machine

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The Ampulco "SHAFT-KING"

SPEED REDUCTION DRIVE

THE MOST ADVANCED UNIT AVAILABLE TODAY

"Shaft-King" is a new Speed Reduction Drive consisting of a compact reduction gear unit mounted on the shaft extension of the driven machine by means of a keyed tapered bushing. It is round like a gear or sprocket and no larger and not much heavier. Connected by a short centre V-Belt drive from the input shaft to a motor of any make or type.

The most important feature of "Shaft-King" is the concentric shaft design which with the overload release torque arm guarantees complete protection against sudden shock loads.

"Shaft-Kings" are made in 3 sizes for ¼ to 12 H.P. in two ratios 13:1 and 20:1. Other sizes will be available shortly.

"Shaft-Kings" are space saving, economical, easy to select and easy to instal. Please write for further particulars.

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(AMPULCO "SHAFT-KING" is a Registered Trade Mark)

P.G. 3

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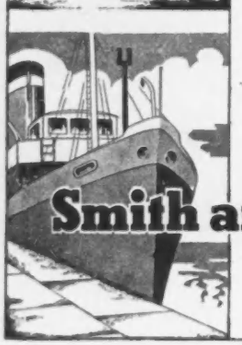
STEEL SHEETS

Light and Heavy Industry are served by Griffin Brand Steel Sheets—Black, Galvanised, Flat and Corrugated.

We make the widest steel sheets and have the largest general galvanising plant in Great Britain.

Metal Spraying by the most up-to-date methods done in our works or 'in situ'.

Metals deposited include: Zinc, Tin, Aluminium, Copper and all its alloys, Cadmium, Monel Metal, etc.



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GLASGOW, C.2.

Tel: CENtral 6442. 'Grams: "CIVILITY Glasgow."

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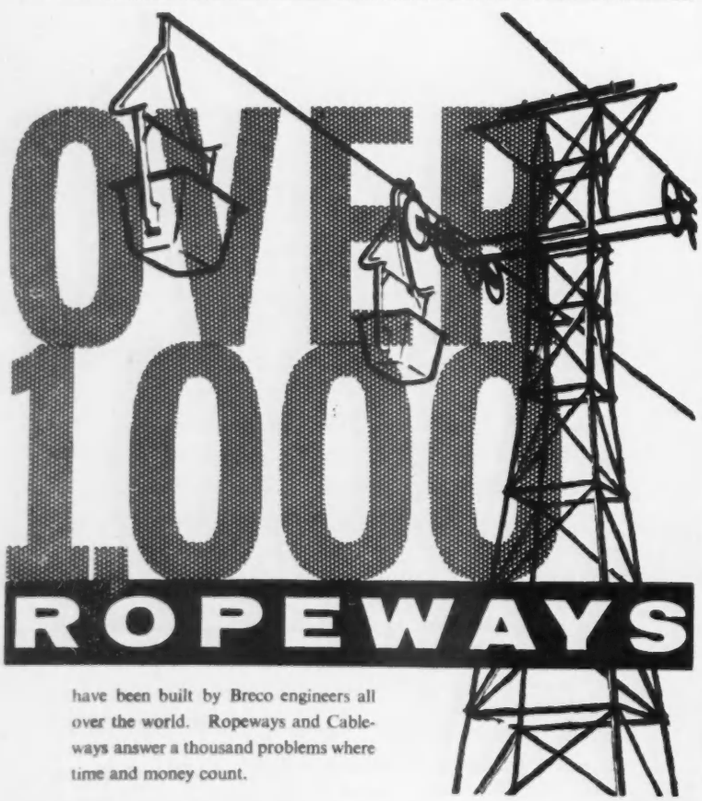

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have been built by Breco engineers all over the world. Ropeways and Cableways answer a thousand problems where time and money count.

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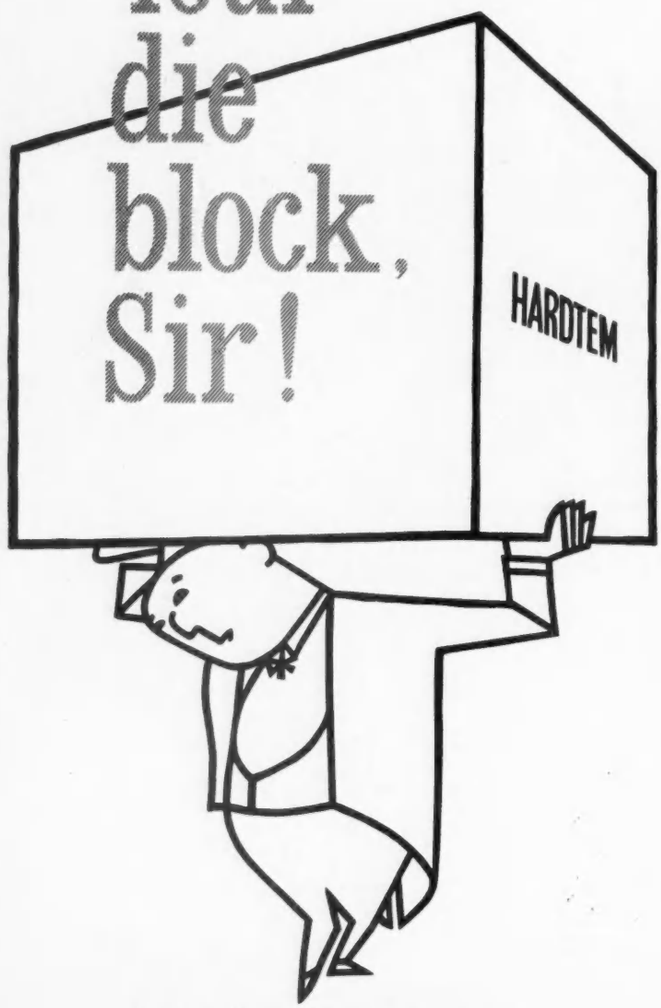
Your die block, Sir!



Service to stamping shops isn't quite as easy as that, but Jessops are now giving rapid delivery of

HARDTEM DIE BLOCKS

now available in weights up to three tons

They can be supplied

either annealed or heat-treated

either black or rough-machined on one or more faces

either with longitudinal or transverse grain flow

in the following hardness grades

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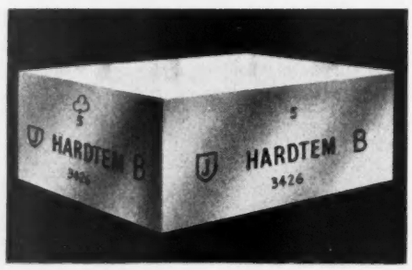

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BRIGHTSIDE WORKS SHEFFIELD ENGLAND
A MEMBER OF THE B.S.A. GROUP

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Consult FILTON For Rotary Unions—

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Unions fitted with carbon bearings are available for temperatures over 400°

For use on all types of Rotary and Semi-Rotary machines for Leakproof Fluid Transfer

Standard Sizes ⅛"—3" B.S.P.

Special Sizes & Designs up to 6" B.S.P.

As used by leading Engineering Companies and Government Departments

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FEED WATER TREATMENT

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What it is . . .

An anti-corrosive alkaline boiler scaling liquid which removes old scale and prevents its further formation. It is easy to use and to control and has no harmful effects on surfaces of boiler and gaskets.

THE MODERN APPROACH TO BOILER PLANT TROUBLES

What it does . . .

It cleans all scale in a period of about 3 months and thereafter positively prevents any scale formation whatsoever. It results in chemically pure (pH-7) steam and no component of the liquid can be detected in the condensate, which will be free from odour or taste.

Technical control service provided at no extra cost.

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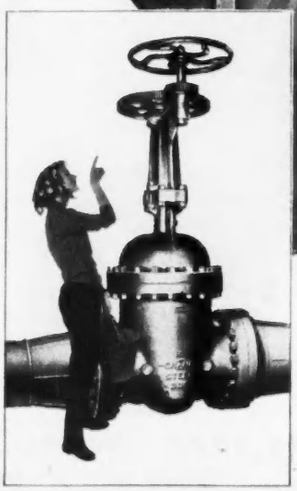

"How do Crane giant valves help to feed my piglets?"

THE pigs, of course, couldn't care less, but the farmer's wife finds it amazing that Crane giant valves help to keep them well fed. However at the Pfizer Organisation, a large chemical producing factory, there is a department specialising in preparations used in pig feeding. And here these valves are performing vital duties during the early processing stages. The industries which Crane giant valves serve are varied and numerous . . . and the giant valve is only one among a wide variety of Crane valves—ranging from ¼" to 24"—each with a tradition of reliable, efficient service. Crane's reputation for reliability lies in their high standard of design, production and precision testing methods.

Among the country's largest industries using CRANE giant valves are:

Esso Petroleum Co. Ltd · British Nylon Spinners Ltd · Imperial Chemical Industries Ltd · Firestone Tyre & Rubber Co. Ltd · Reed & Smith Ltd · 'Shell' Refining Co. Ltd · Pfizer Ltd.

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THE GENERAL PURPOSE FASTENER FOR ENGINEERS.

Simple—Positive—Self Locking. Made in a variety of types and sizes. Special Fasteners to suit customers' requirements.

Used on aircraft, automobiles, coaches, caravans, rail coaches, electrical, radio and radar units, refrigerators, marine craft, display equipment, etc.

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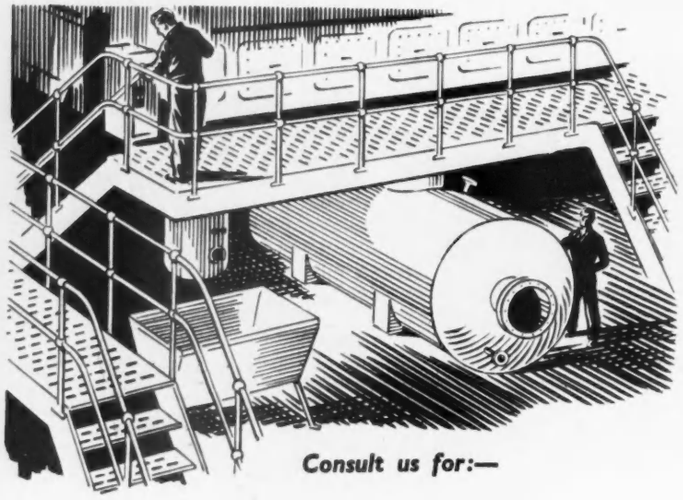

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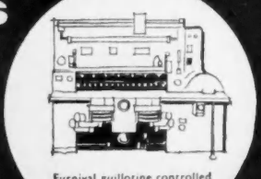
Warner *Electric* brakes & clutches

act like lightning!



Furnival guillotine controlled electrically by Warner Clutches and Brakes

This high speed carpet spinning machine is controlled by a Warner 1000 Electric Clutch

Warner Electric Brakes and Clutches are manufactured in Gt. Britain under licence by:

WESTOOL LIMITED

ST. HELEN'S AUCKLAND, Co. DURHAM

Phone: West Auckland 551/5

Grams: Solenoid, West Auckland.

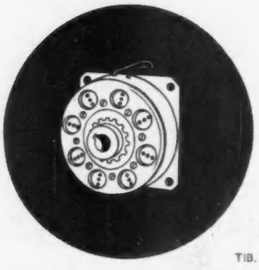
LONDON: 2 Ashley Place, London, S.W.1.
Phone: Victoria 7301/2

BIRMINGHAM: 7 Newhall St., Birmingham 3
Phone: Central 3901

Smoothly and rapidly, Warner Electric Brakes and Clutches are taking push-button control of Britain's industry. These control units — standard equipment in machine shops of the U.S.A.— point the electronic way to major improvements in numerous types of machines.

IMMEDIATE ADVANTAGES: versatile, compact, *instantaneous* in response, Warner units solve starting and stopping problems effectively and economically. Furthermore, they have been completely successful on applications controlling speed, tensioning, positioning, coupling, indexing and rapid cycling. They can be fitted to existing machines; they enable new machines to be smaller, faster and easier to operate.

Take the quickest step to increase your production—ask about Warner units. *Full technical advice is always available.*



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TAKE THE LEAD — LET WARNER ELECTRIC BRAKES AND CLUTCHES TAKE CONTROL

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the name of

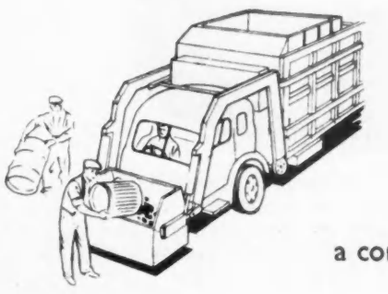
CAMBRIAN WAGON & ENGINEERING CO. LTD.

has been changed to

POWELL DUFFRYN ENGINEERING CO. LTD.

The Company will continue the production of all forms of railway rolling stock whilst expanding its activities in other fields including liquid storage tanks, process and pressure vessels, and the fabrication and erection of bulk storage installations.

In addition the Company has now undertaken the manufacture under licence of



THE DEMPSTER DUMPSTER SYSTEMS

a complete range of mobile equipment for waste and materials handling.

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POWELL DUFFRYN ENGINEERING CO. LTD.

CAMBRIAN WORKS, MAINDY, CARDIFF

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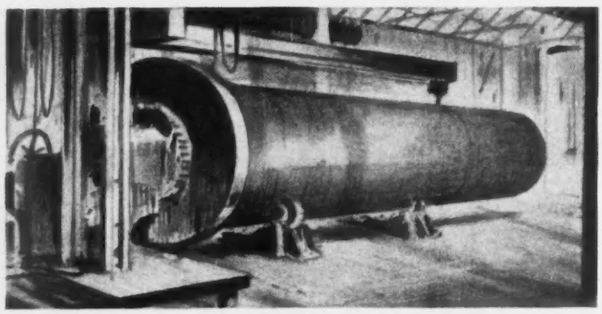
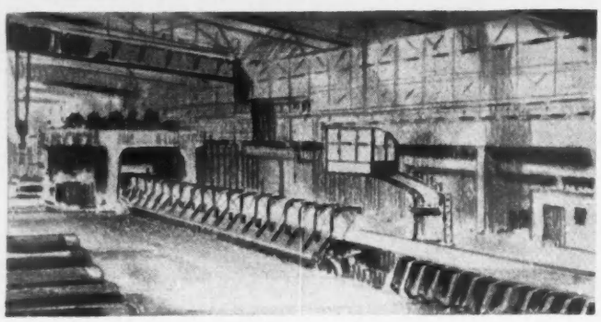
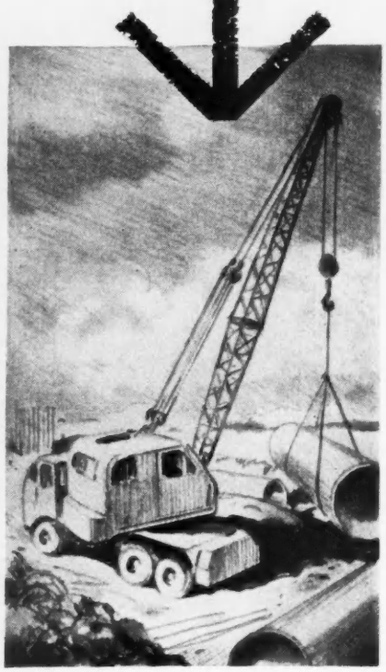
If your problem is tilting moments*







*turn to the Cross-Roll Bearing

Evolved, perfected and manufactured in Great Britain in collaboration with British Timken Limited.

The Priestman Cross-Roll Bearing consists of four separately machined rings. When bolted together in pairs the roller paths form a diamond pattern race section.

The Timken tapered rollers, spaced on the pitch circle by pressed steel cages, alternately contact opposing race surfaces of the outer and inner rings. The crossing of the roller axes in combination with the inclination of the roller paths is the feature that enables the Bearing to resist loads in all directions.

Priestman Cross-Roll Bearings are pre-loaded, pre-lubricated, and sealed self-locating assemblies, requiring no adjustment and little maintenance beyond the periodical replenishment of grease in the labyrinth which supplements the special synthetic rubber cruciform seal, excluding all foreign matter.

PRIESTMAN

PRIESTMAN BROTHERS LIMITED, HULL, ENGLAND

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Why RECTANGULAR hollow sections?

The technique of welding tubular steelwork has recently made great advances and a wide range of products from the simplest to the most complex is now produced. Much of this progress is due to the work of our subsidiary company, Tubewrights Ltd., and their recent experience has shown that for many types of construction

RECTANGULAR HOLLOW SECTIONS

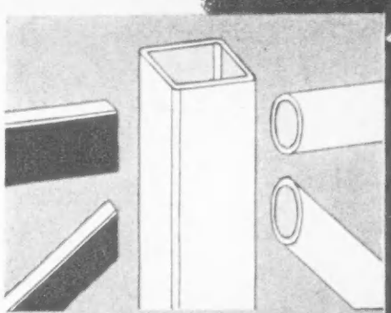
offer considerable advantages over other sections.

Stewarts and Lloyds are therefore now producing a range of hot-rolled square and other R.H. Sections in 17 standard sizes, each in two thicknesses, as follows:

RHS

□ INCHES	S.W.G	▯ INCHES	S.W.G
1 × 1	12g, 10g	2½ × 1⅜	11g, 9g
1⅜ × 1⅜	11g, 10g	3⅛ × 1⅝	10g, 9g
1⅞ × 1⅞	11g, 9g	3⅝ × 1⅞	10g, 8g
2⅛ × 2⅛	10g, 9g	4¾ × 2⅜	9g, 7g
2⅜ × 2⅜	10g, 9g	1⅞ × 13/16	11g, 10g
2½ × 2½	10g, 8g	2¾ × 1	11g, 9g
2¾ × 2¾	10g, 8g	3⅜ × 1⅜	10g, 9g
3⅝ × 3⅝	9g, 7g	4 × 1⅝	10g, 8g
MATCHING DIMENSIONS ARE SHOWN IN HEAVY TYPE		5 × 2⅛	9g, 7g

LARGER SIZES ARE ALSO NOW AVAILABLE



R.H. Sections have flat sides which eliminate the need for special shaping prior to welding.

No further preparation of the part to be welded is needed whether it is another R.H.S., a tube or a length of bar, or whether it is cut off square or at an angle.

Our subsidiary, Tubewrights Ltd., of 25 Buckingham Gate, London, S.W.1, is willing to advise about or quote for any welded sub-assemblies in R.H. Sections, in tubes, or in a combination of both.

STEWARTS AND LLOYDS WAREHOUSES THROUGHOUT THE COUNTRY STOCK R.H.S.

Pamphlet giving full dimensions, properties and prices will be sent on application to:

Stewarts and Lloyds Ltd

STRUCTURAL STEEL DEPARTMENT
BROAD STREET CHAMBERS, BIRMINGHAM, 1

STEWARTS AND LLOYDS S&L RECTANGULAR HOLLOW SECTIONS TUBEWRIGHTS

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D

Flash Welding . . .

. . . Extraordinary . . .

. . . up to 15 sq. ins. in Mild Steel, 6 sq. ins. in Titanium Alloys : up to 5 sq. ins. in "Nimonic" 75 and 2 sq. ins. in "Nimonic" 90 ! Complete uniformity of weld quality and accurate tolerances minimise machining and improve yield. Reynolds Flash Welding facilities include machines of up to 60 tons upset capacity.

Write for full details.

REYNOLDS

REYNOLDS TUBE CO. LTD. TYSELEY BIRMINGHAM 11 E.13.

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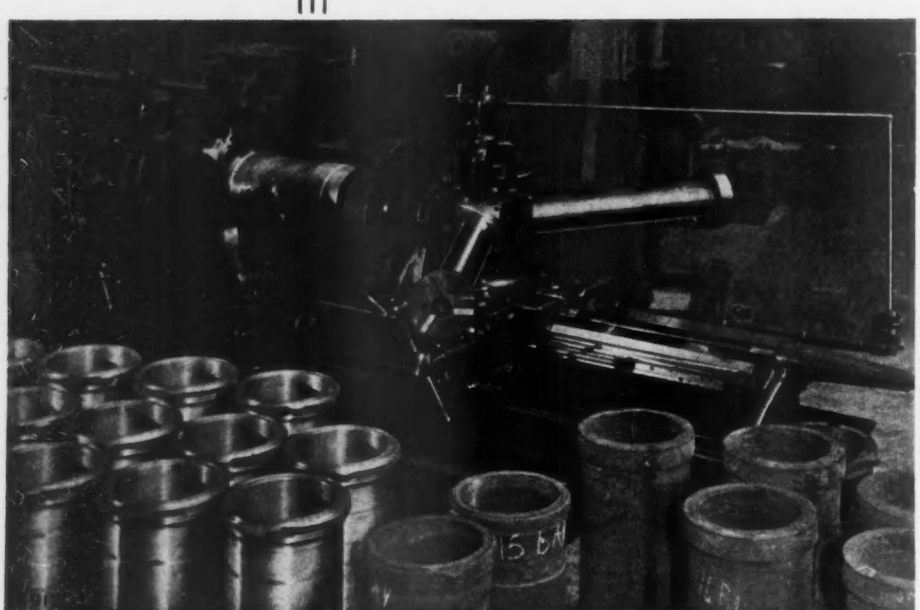
for Heavy Turret Lathe Work
the HERBERT No. 14/36 Combination Turret Lathe



With a swing of 36in. and a drive motor of 50 h.p. it has all the advantages common to all sizes of Herbert Capstan and Turret Lathes—the power, speeds and rigidity to use carbide tools to full advantage, ease of setting up which makes for economical machining of one or two similar components, fast cutting times, high and consistent accuracy and excellent finish. Thirty-two speeds, 4 to 480 r.p.m. Sixteen reversible automatic sliding and surfacing feeds to saddle. Quick-power traverse to both motions. Chasing mechanism. Sixteen automatic feeds and quick-power traverse to turret slide. Hole through spindle, 8½in.

A Herbert No. 14/36 Combination Turret Lathe, with special tooling for machining cylinder engine liners, installed in the Rugby Works of the English Electric Company. Machined in a total time of 5 hours, four operations. External diameters are held to ±0·001in., bore parallel, concentricity and ovality to ±0·002in.

ALFRED HERBERT LTD., COVENTRY

AD. 324

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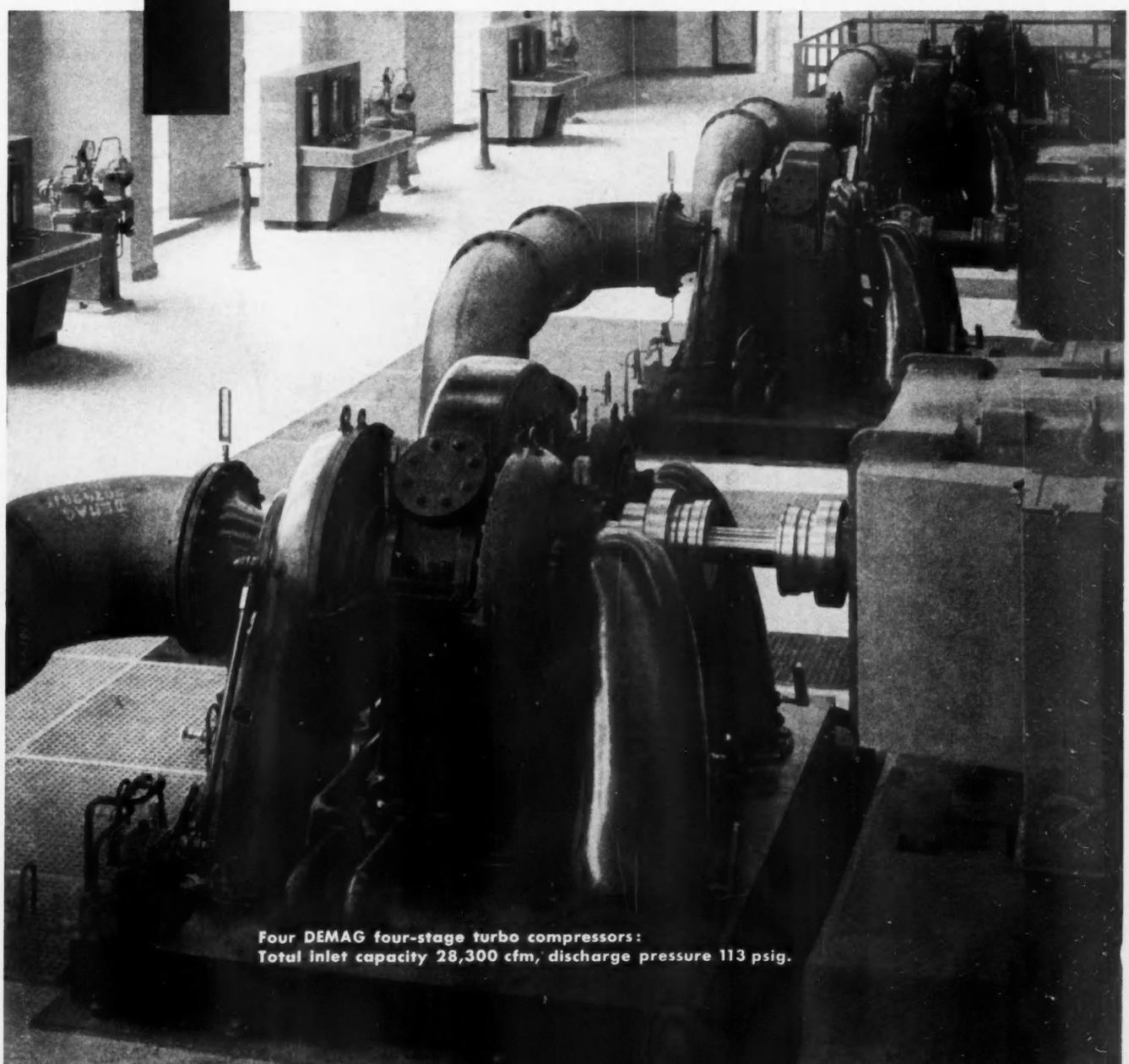
DEMAG

Outstanding for its particularly economic operation among the compressors of DEMAG's comprehensive manufacturing programme is the four-stage turbo compressor, which has two shafts. This compressor, designed for inlet capacities of 5,000 to 30,000 cfm at pressure ratios between 5 and 15, is built for compressing air.



Four DEMAG four-stage turbo compressors:
Total inlet capacity 28,300 cfm, discharge pressure 113 psig.

For U. K. represented by:
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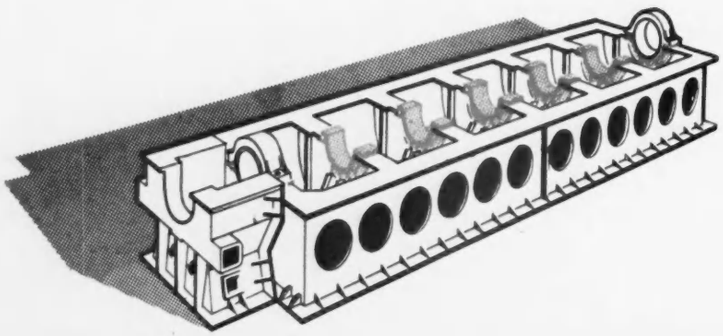

15% reduction in cost

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This cast steel bearing saddle for the Scott-Doxford Marine engine replaces a more expensive forged block. Freedom of design in steel castings and modern fabricast techniques enabled it to be made to meet functional requirements to an extent not possible by any other method.

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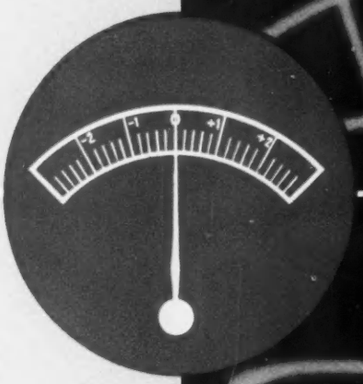
THE ENGINEER
Oct. 9, 1959

The Anatomy of Newman Quality—4

NEW FEATURES

allied to proved principles

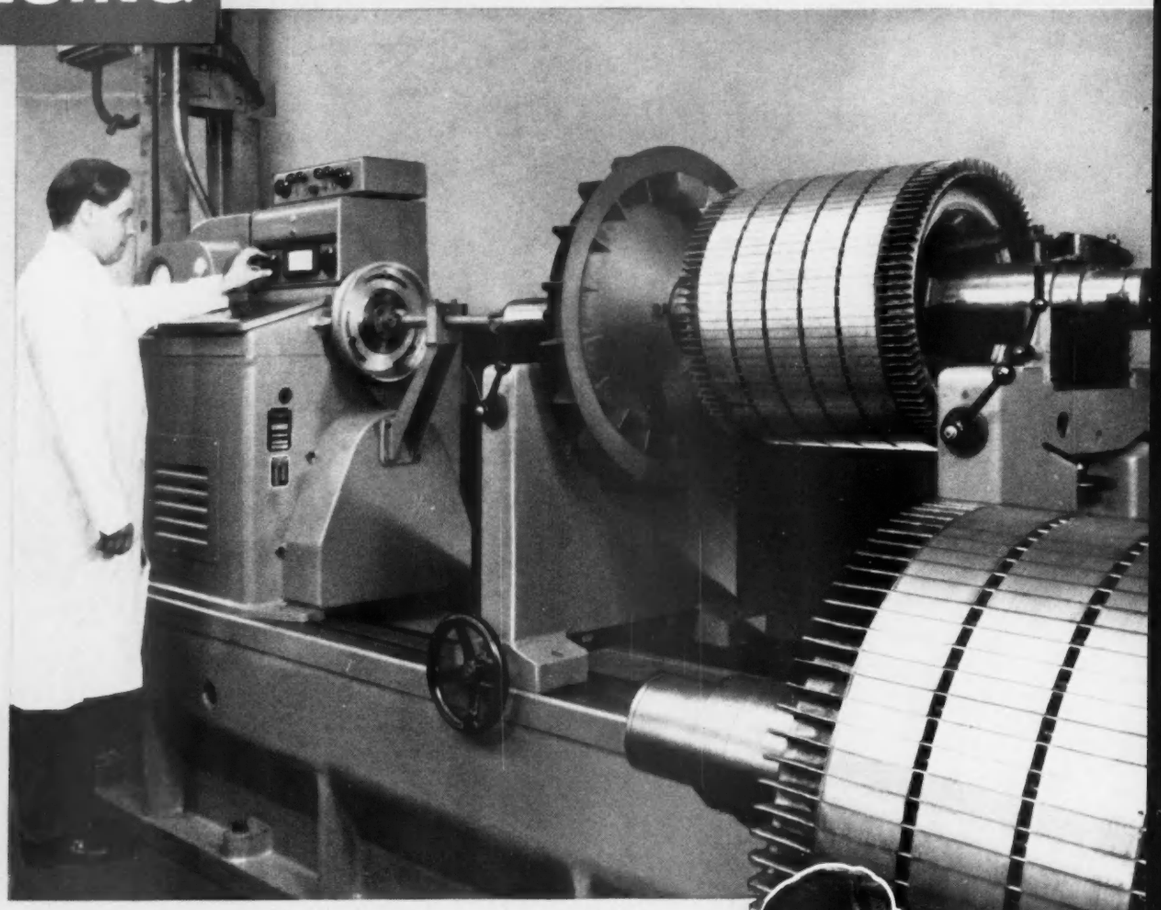


BALANCE

Newman

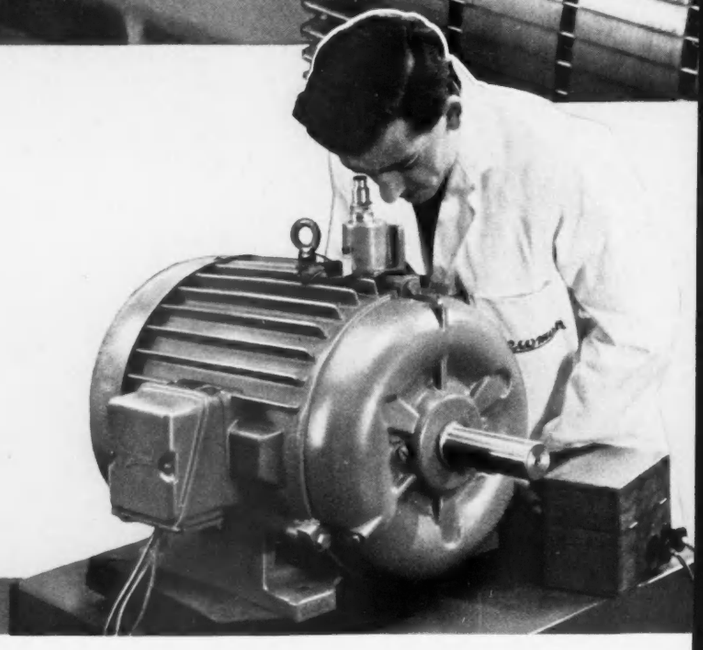
Making the pace
in motor progress

Newman BALANCING



Every Newman rotor is balanced on dynamic balancing machines similar to that shown right. These machines not only indicate precisely the degree of unbalance but also show the exact position on the rotor where correction should be applied.
The photograph below shows a final check for vibration, on a completed motor, using a Genevoise vibrometer.

Newman are specialists in the manufacture of electric motors. Every single motor produced—whatever its size in the range $\frac{1}{16}$–600 hp—is dynamically balanced to very high standards on the most modern equipment. For example, all Newman rotors are balanced as a production " norm " to ·0005 inches vibration, which is to a finer degree than that specified by NEMA (National Electrical Manufacturers Association—there are no official standards of balance in this country). But for machine tool manufacturers and others who incorporate Newman motors in precision machines, the rotors are balanced to within ·0003 down to ·0001 inches maximum vibration according to the application. Electrical design can be an important influence in reducing vibration for example, by the right choice of rotor and stator laminations. Mechanical design can similarly reduce vibration by ensuring rigidity of components and by such features as lightly pre-loading ball bearings—standard practice on all Newman motors. By tackling the important feature of balance both from the design side and by the accurate testing of component parts, Newman ensure that their motors give longer life, unfailing power and the greatest economy in operation.



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For any assistance or consultation you desire in the field of dust collection or recovery, simply write or telephone our London office. An illustrated 16-page booklet is available on request:
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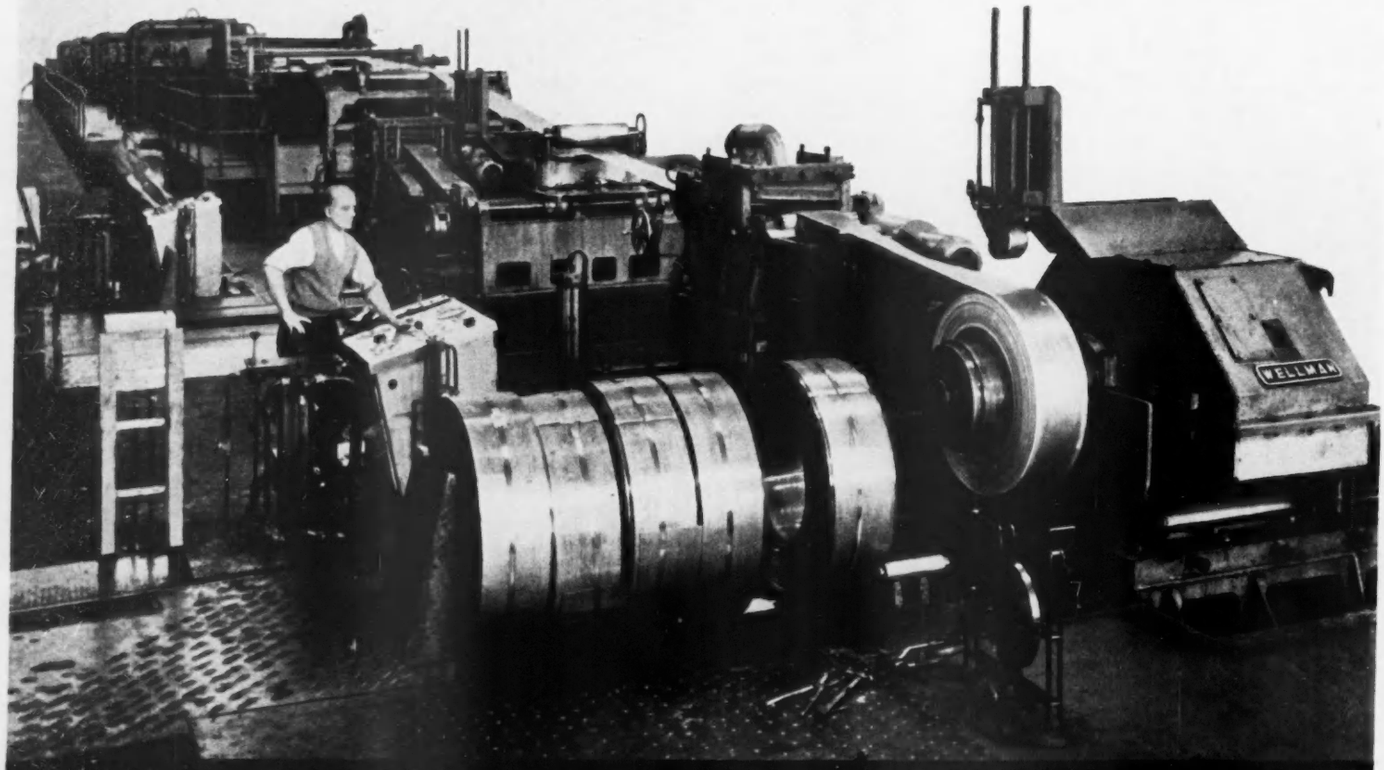
Below is illustrated the exit end of a Wellman Multi-Strand Continuous Pickle Line, for processing low carbon and mild steel hot rolled strip, installed at the Works of a large Sheffield manufacturer. The line is at present operating with two strands, but will ultimately be arranged for four-strand simultaneous processing.

This is one of the numerous Wellman installations in both the United Kingdom and Overseas, designed for the continuous processing of low carbon, mild, silicon and stainless steels in a wide variety of gauges and widths.



THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LTD

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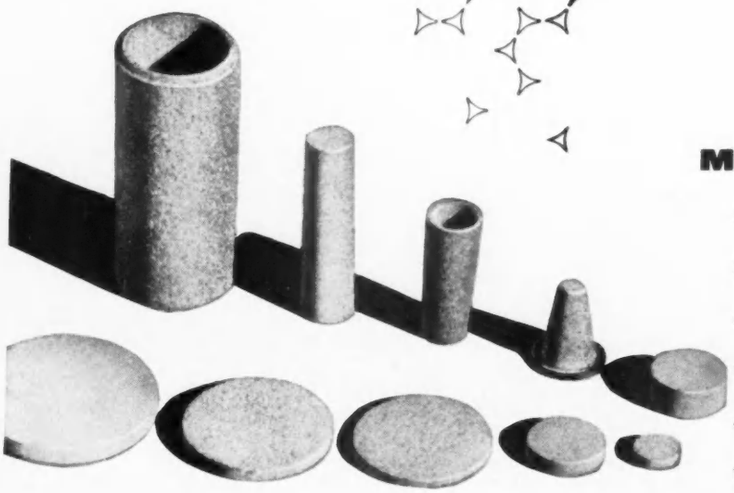
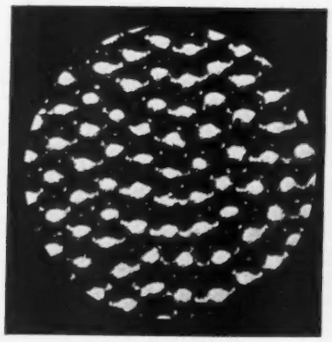


Many years' experience in powder metallurgy has resulted in the development by BOUND BROOK of a porous material for the filtering of liquids and gases. It is produced from spherical metal powders of *closely controlled particle size* to give a rigid porous bronze structure of *uniform pore dimensions*. This metallic structure has excellent resistance to impact, is suitable for high pressure filtration in both directions of flow, and enjoys an almost indefinite life. The material is easily cleaned either by washing or by reversing the flow. Designed for such applications as filter elements, flow control devices, flame traps etc., BOUND BROOK bronze filters are available in six grades to suit required conditions, and in the form of discs, plates, cones, hollow cylinders etc. Special shapes can be made to suit customers' requirements. For further information send for leaflet "BOUND BROOK Bronze Filters".



This photomicrograph shows a section of a Bound Brook filter. Note the porous structure formed by the use of spherical metal powder

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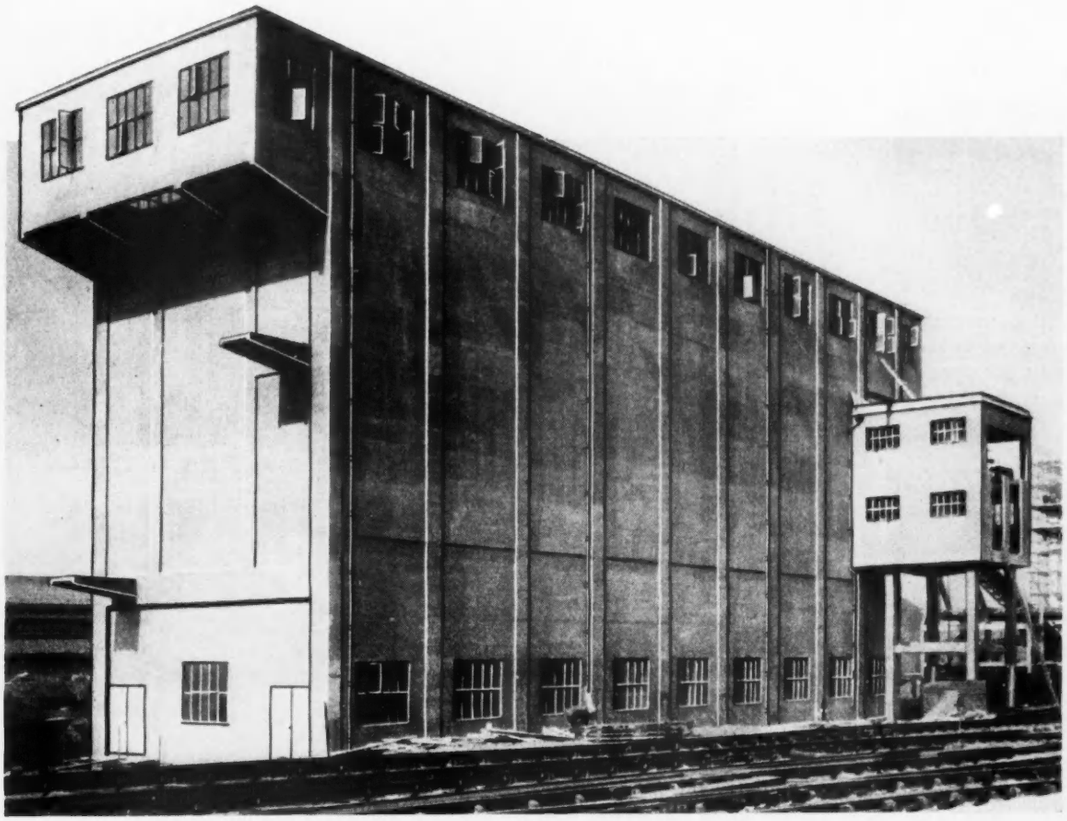

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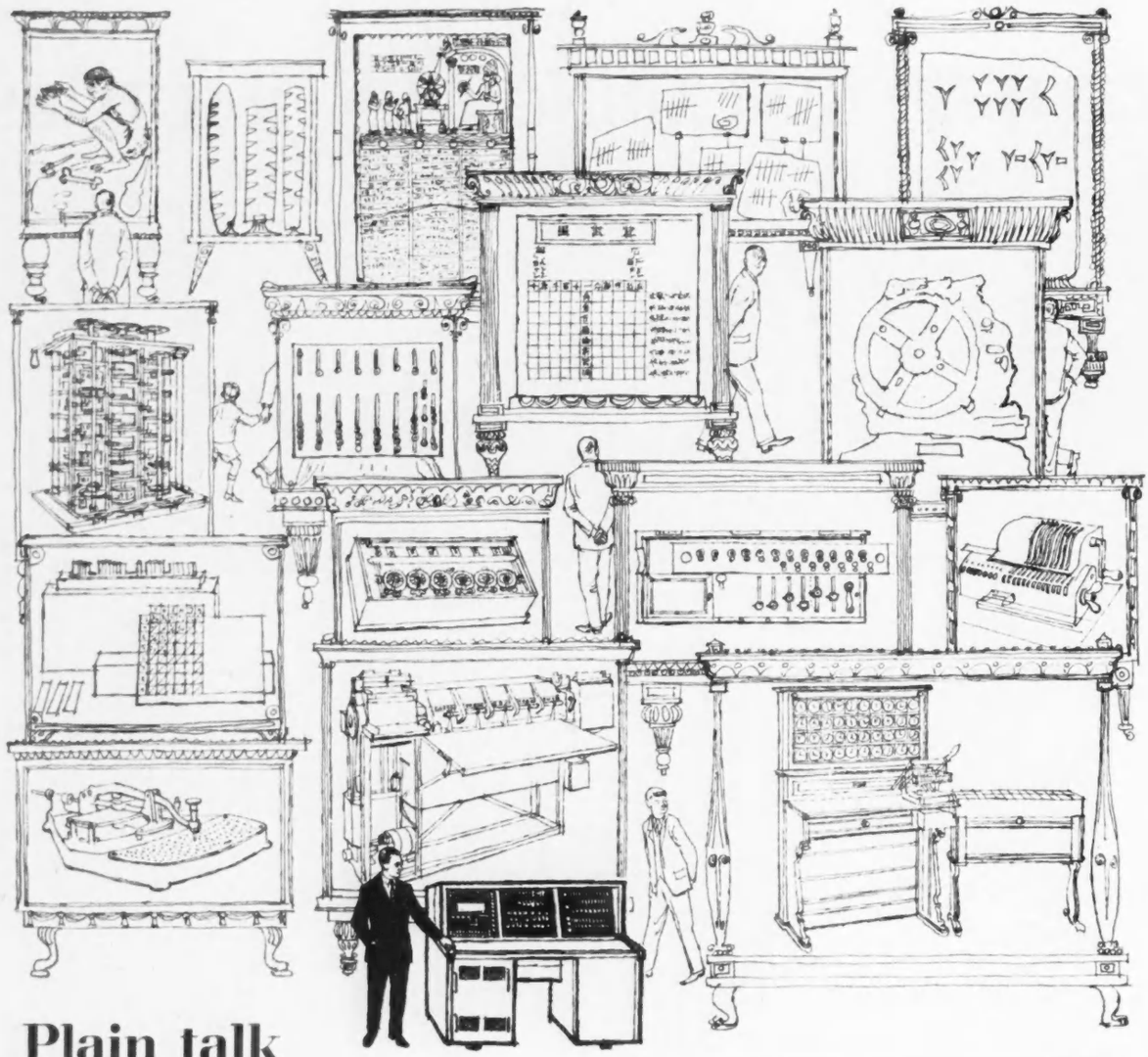

Plain talk about data processing

From the time the first man stood on his hind legs and counted on his fingers, he has been using the best data processing system of all, the one in his cranium. He stored up his information and when he was faced with a problem he consulted his records and used them to decide on the right course of action. As his affairs grew more complicated and he turned into a business man he tried very hard to predict things to come. But the cold truth is, as he discovered when his crystal fogged over, the only real way to predict the future is to reconstruct the past and to study it in relation to present facts and future trends. To do this, facts and figures are needed in an accessible form, and that's what modern data processing does for him. And, into the bargain, it takes a great load of drudgery off his shoulders (and the shoulders of his staff).

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I·C·T service begins with your enquiry. Alongside your own executives, I·C·T specialists will study your business to see if I·C·T data processing equipment will help you. If it won't they will tell you. If it will they'll give you a detailed report of their recommendations and their economics, specifying equipment tailor-made to meet your exact needs. I·C·T trains your staff, and special courses ensure your executives gain the background knowledge to make the equipment earn every penny of its keep. The same service sets the installation on its feet and is available to you throughout its life.

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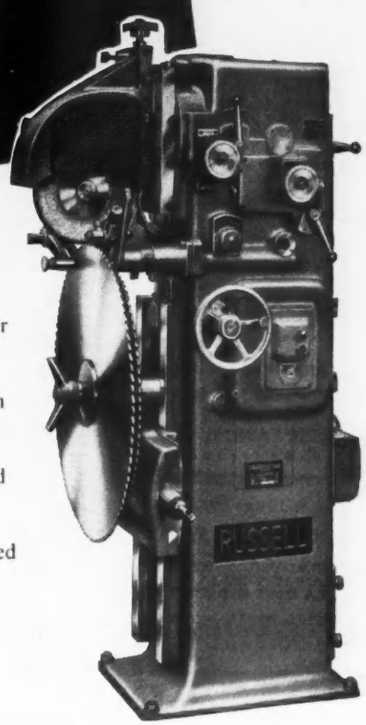

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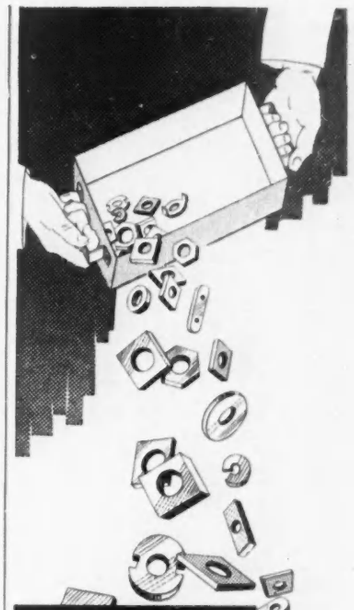

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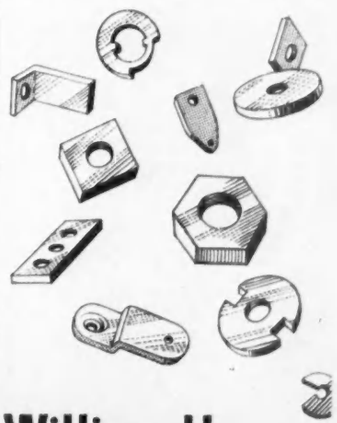

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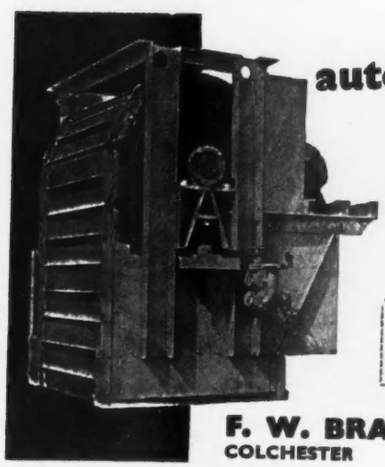

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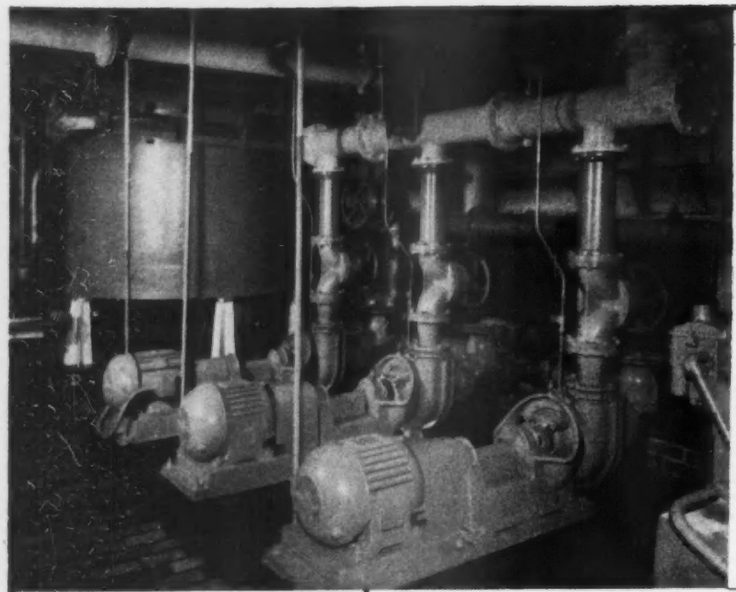

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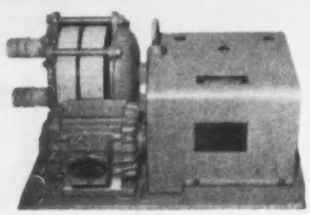
(Bottom left) Close-up view of diaphragm pump similar to the hand operated unit but arranged for motor drive
(Bottom centre) Hand operated portable diaphragm pump for emptying carboys or tanks and for general duties.
(Bottom right) Portable rotary displacement pump pumping plating solutions in the motor car trade



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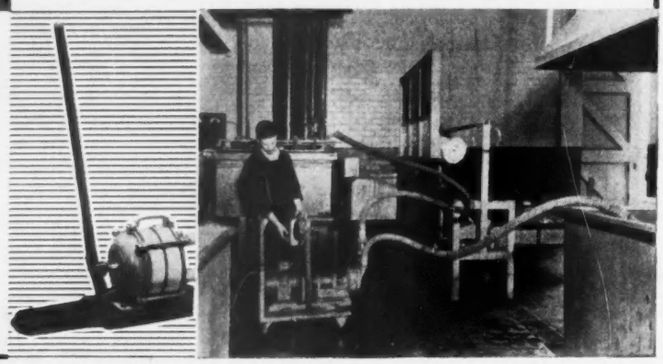

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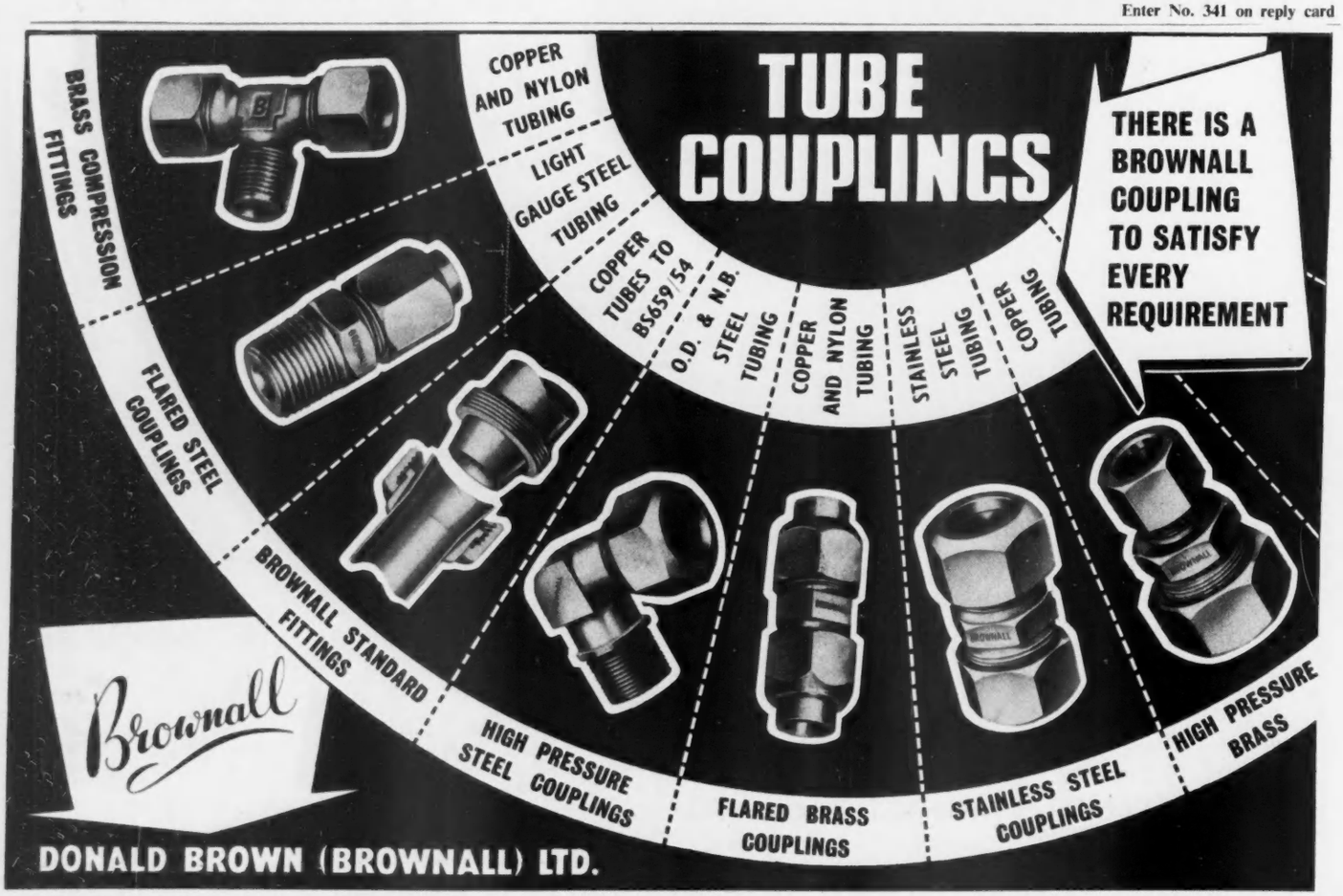

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You will agree, won't you, that air in steam plant is a dead loss. It not only cannot give up heat but it actually prevents the surrounding steam from giving up *its* heat.

If the air mixes with your steam, then it can make nonsense of what your pressure gauge is showing in terms of usable heat. If it forms pockets or films, then your heat transfer is uneven, increasing your spoilage rate and probably giving your production people pains in their heads.

The shortest course of action is to ask for our two Information Sheets about air in steam plant. If what they say seems to make sense, you might even be encouraged to see what we have to say about other unprofitable aspects of steam usage. There may even be one or two of these which you haven't thought of : if we can help to get to the root of some of your troubles, we'll be only too happy.

By the way, air in hot water plant doesn't make sense either.

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Please post . . . copies of " Air in steam heated plant " and " Air venting of large steam spaces "

. . . copies of Pamphlet 108 " Air removal from steam and hot water plant."

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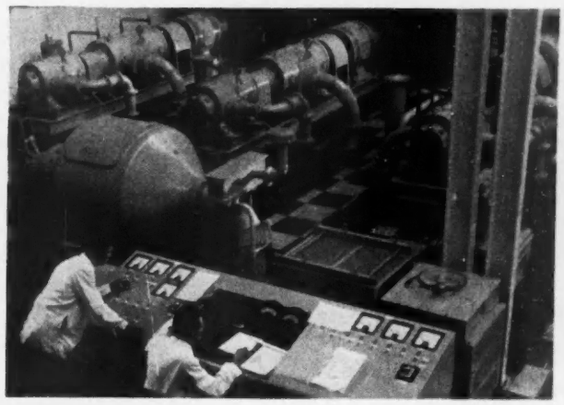

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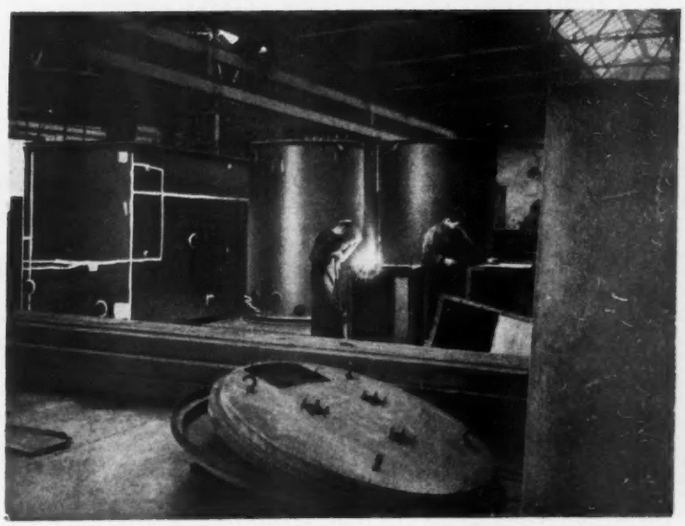

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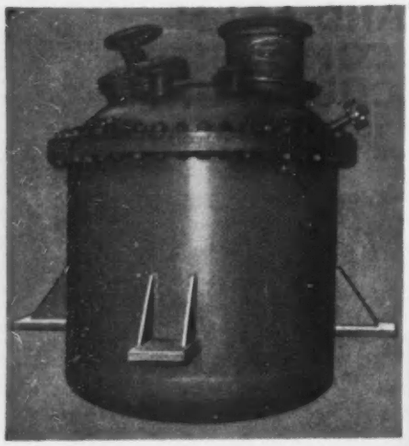

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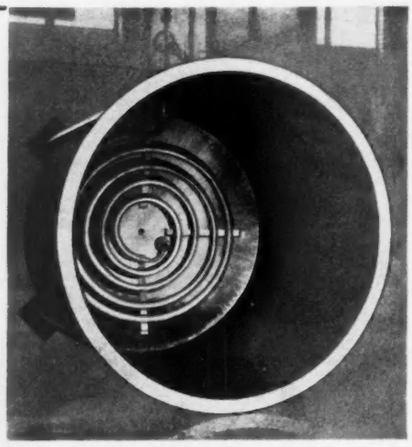

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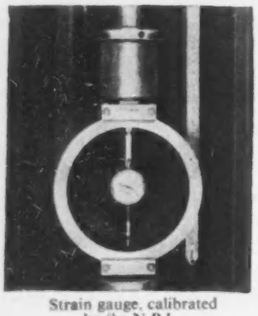
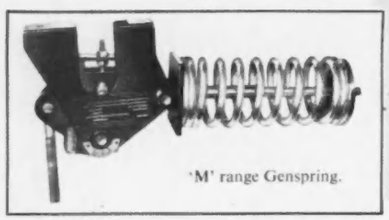
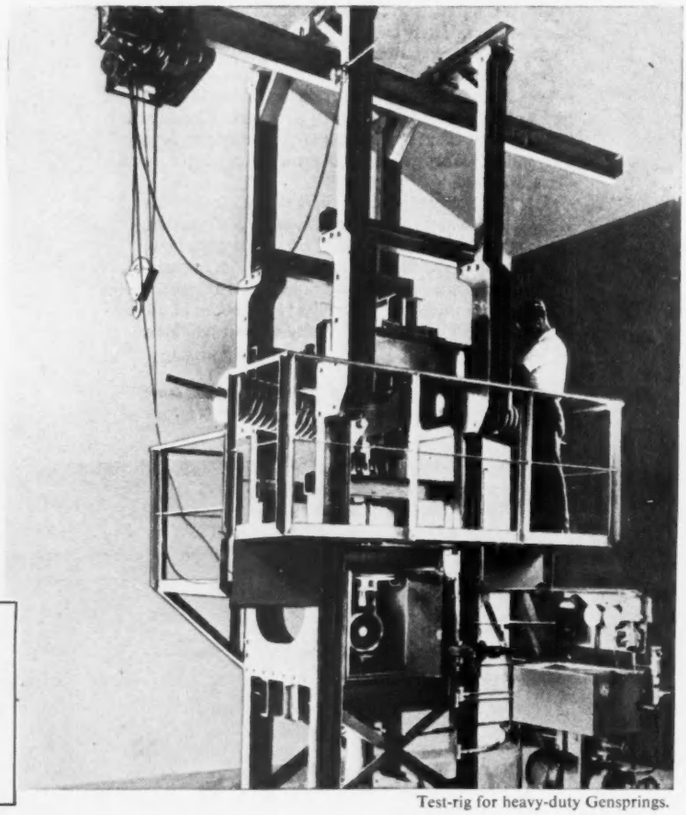


Strain gauge, calibrated by the N.P.L.



'M' range Genspring.



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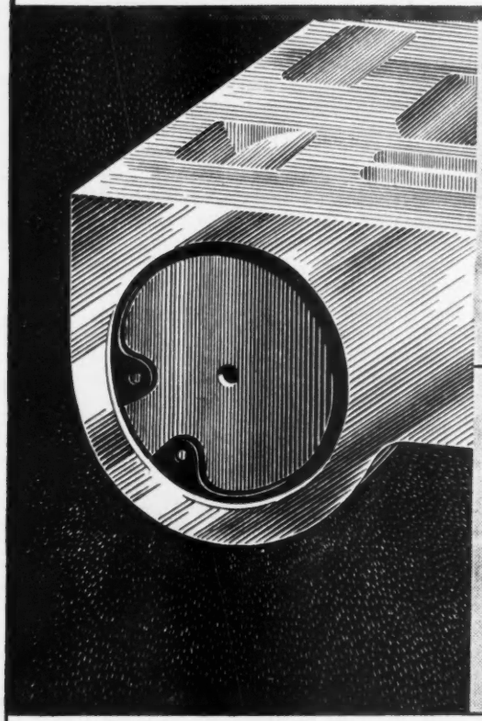

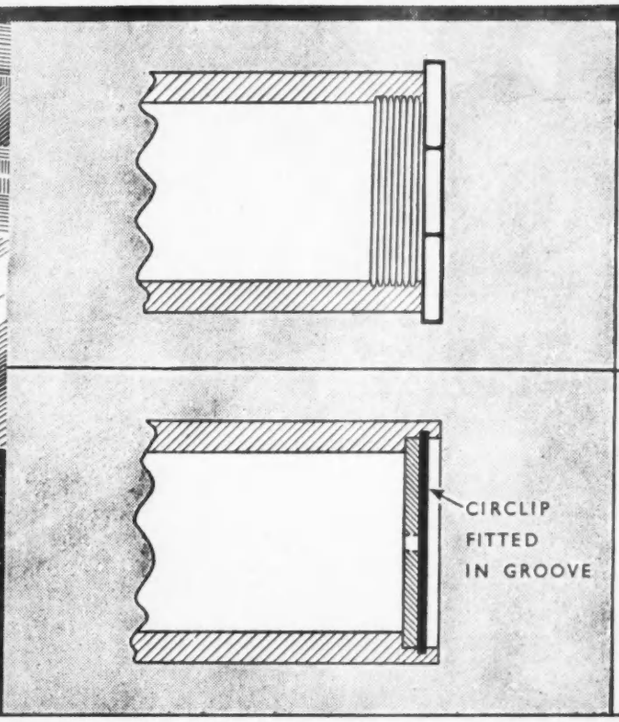

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This fluid seal involved internal threading of the tube, which was sealed with an expensive cap-nut. The assembly was laborious and spanners were needed.

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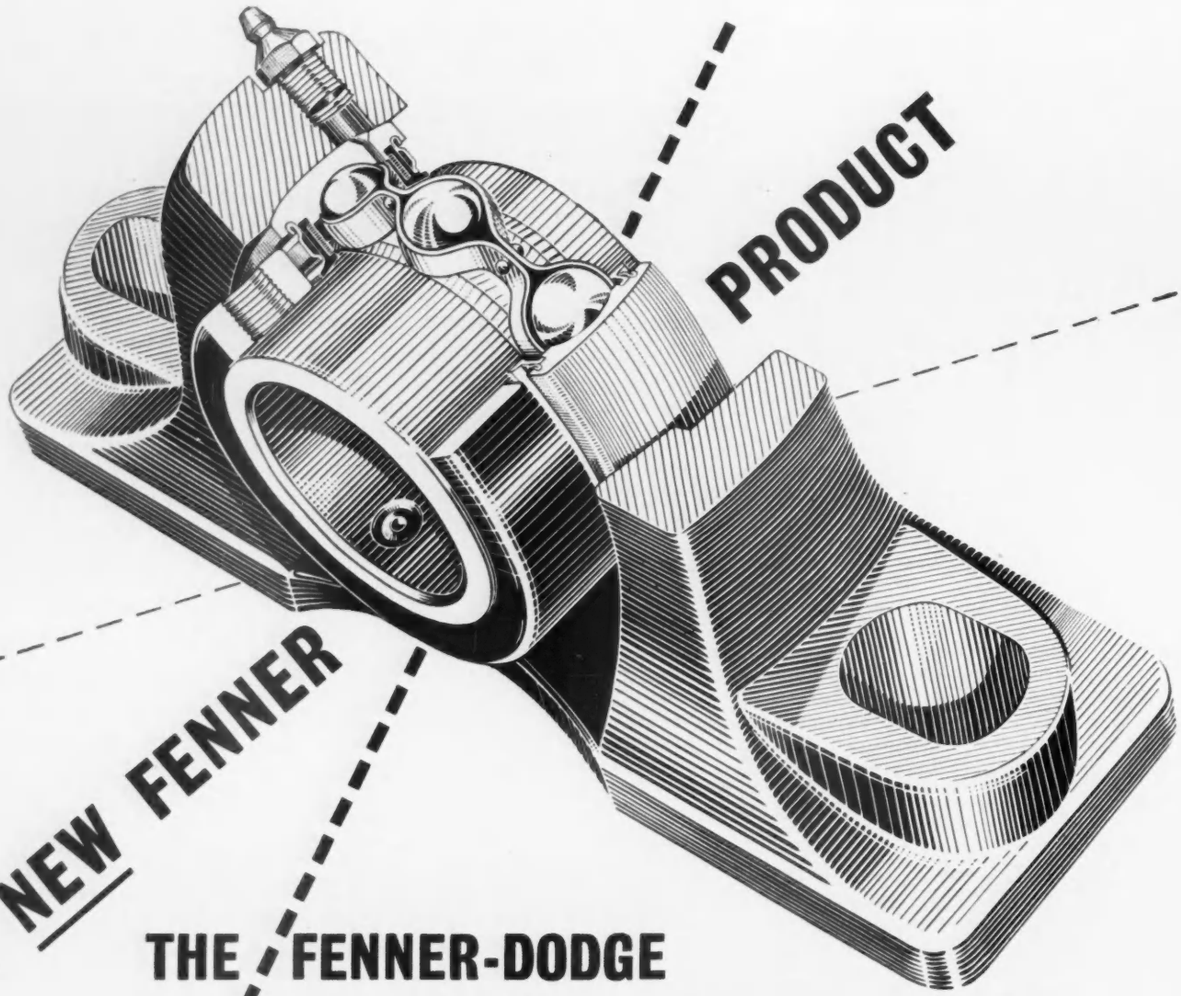

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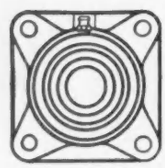

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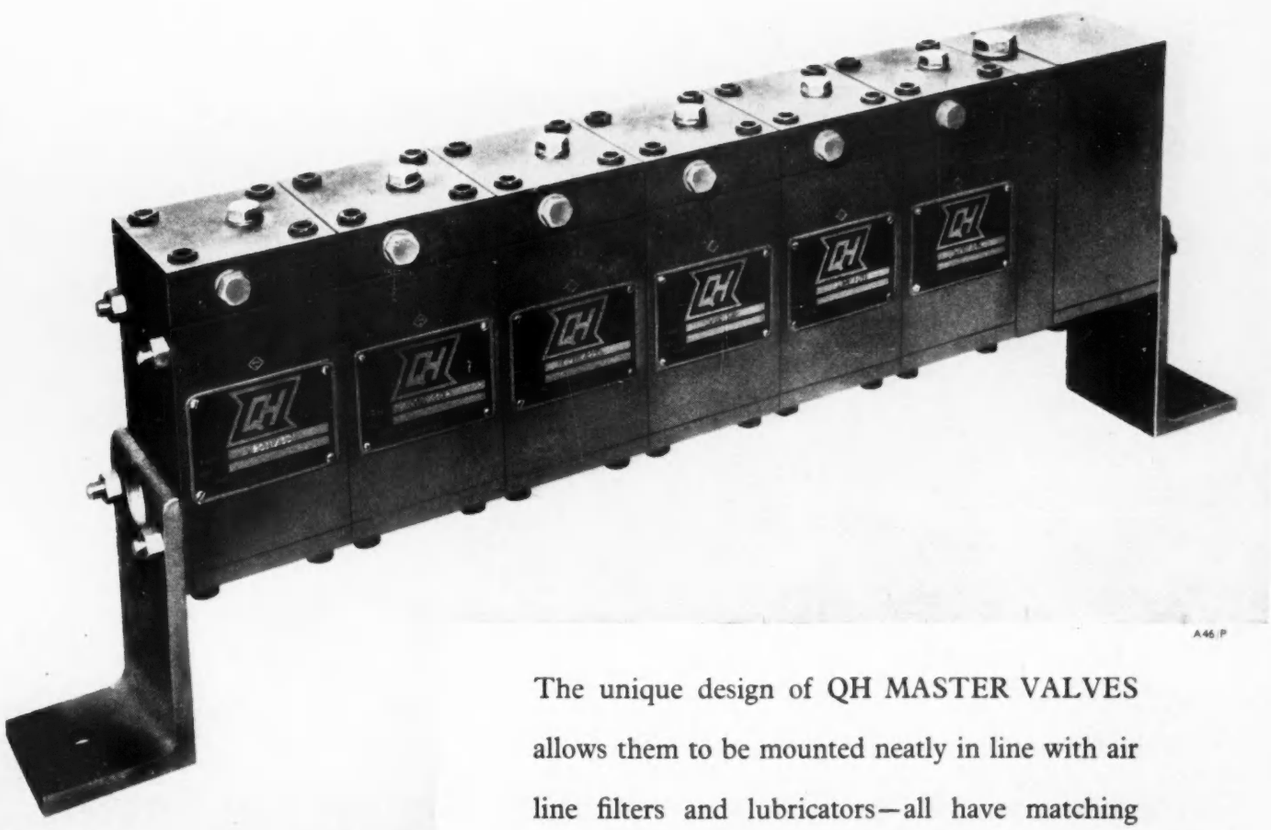

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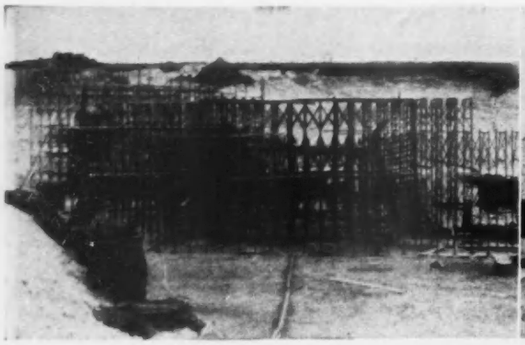
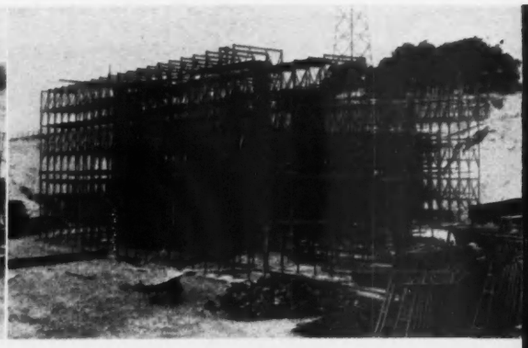
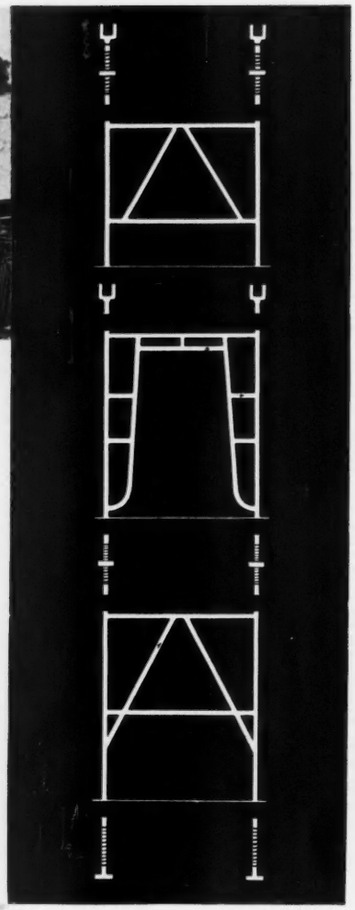




The photographs show Sterling Safway Scaffolding in use at No. 6 Bridge on St. Albans Bye-Pass built by Messrs. TARMAC Ltd.

The pre-fabricated unit frames are light to handle, strong and rigid in use and are available in various heights to a standard width of 5 ft., 2 ft. 6in. x 2 ft. allowing access through the scaffolding where required. Safway can be bought, hired or supplied on contract inclusive of labour and transport.



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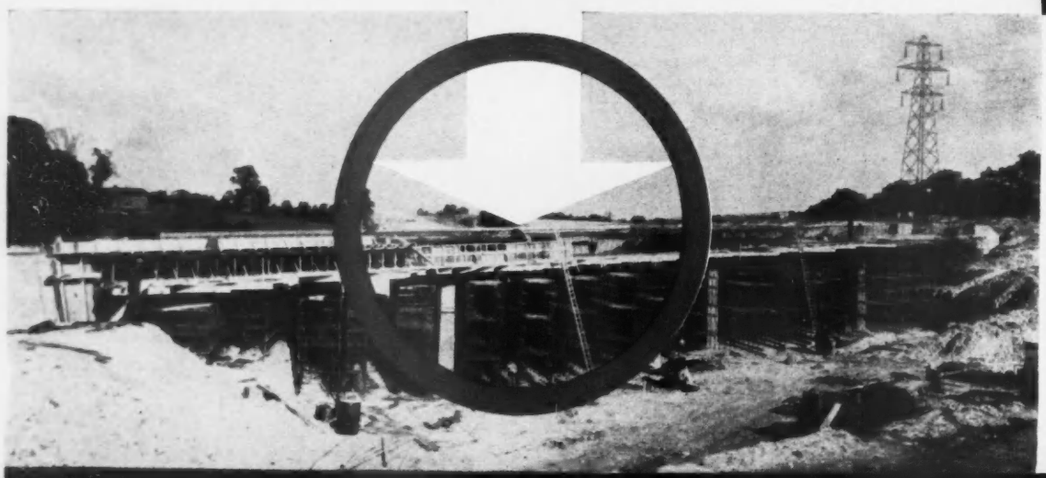

Large load-bearing structures easily and quickly built from standard Sterling Safway Unit Frame Scaffolding

SCAFFOLDING

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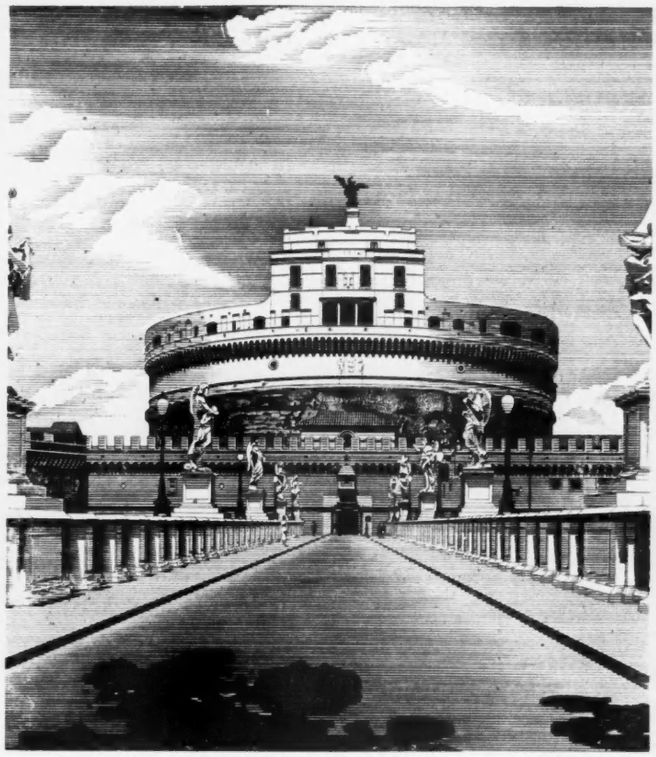

Wonders of the World

HADRIAN, Roman Emperor, built this mausoleum for himself and his successors over 1800 years ago. Originally it was encrusted with magnificent marble and the circular wall was crowned by a cone of earth planted with trees. Hadrian also built the bridge which gives access to the tomb. The mausoleum eventually became the medieval citadel of Rome and is now known as the Castle of San Angelo.

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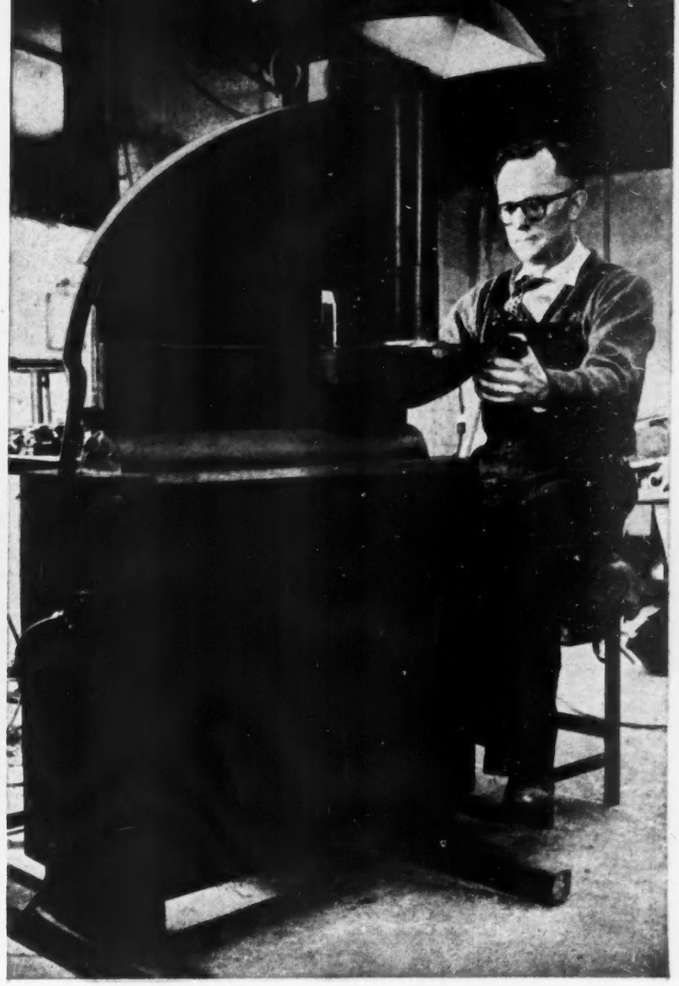

This formidable Hydraulic Cropper can cut, for instance, 2″ x ½″, 3″ x ⅜″ and 4″ x ¼″ thick Flat Mild Steel in one stroke and also ¼″ thick Sheet and Plate to any width and all controlled by the simple pressure of the foot. It's speedy, for you can get up to 34 cuts per minute with only negligible burr. It is only 3′ 0″ x 1′ 0″ x 5′ 0″ high and weighs but 5 cwts.

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110-RB Ward-Leonard electric shovel in a quarry excavating limestone after blasting. (Belgium)

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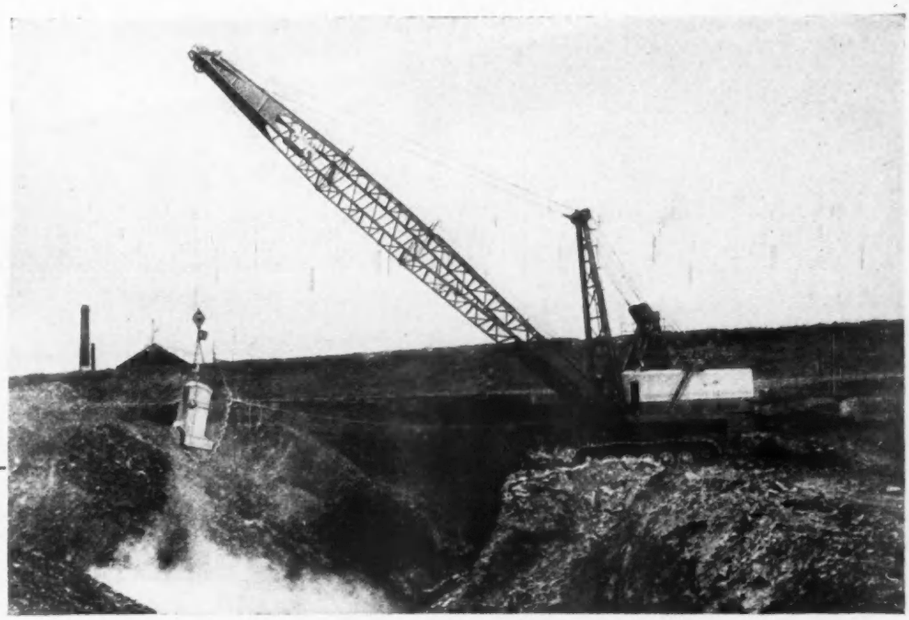
Ward-Leonard electric control with independent motor powering of hoist and drag functions.

150-RB dragline on long, wide caterpillar mounting excavating 60' of shale overburden on an opencast coal site. The machine is fitted with 100' boom and 6 cubic yard B A X dragline bucket.



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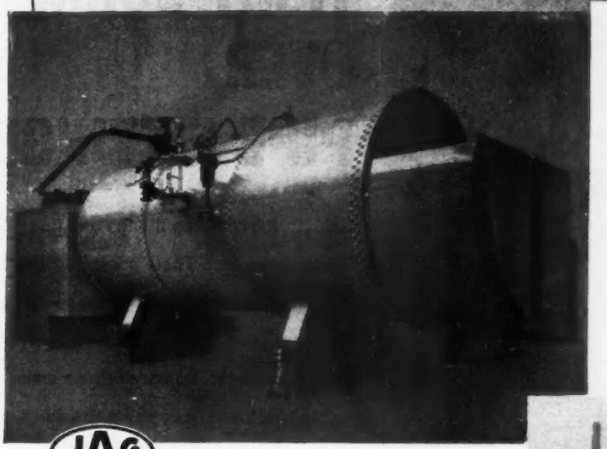

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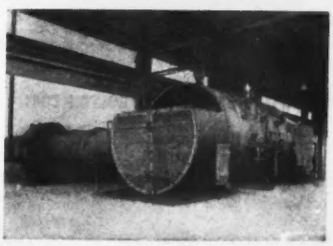

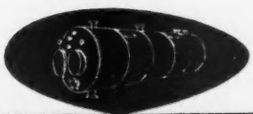

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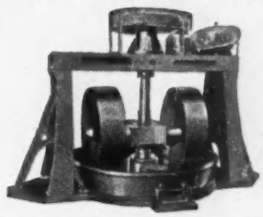

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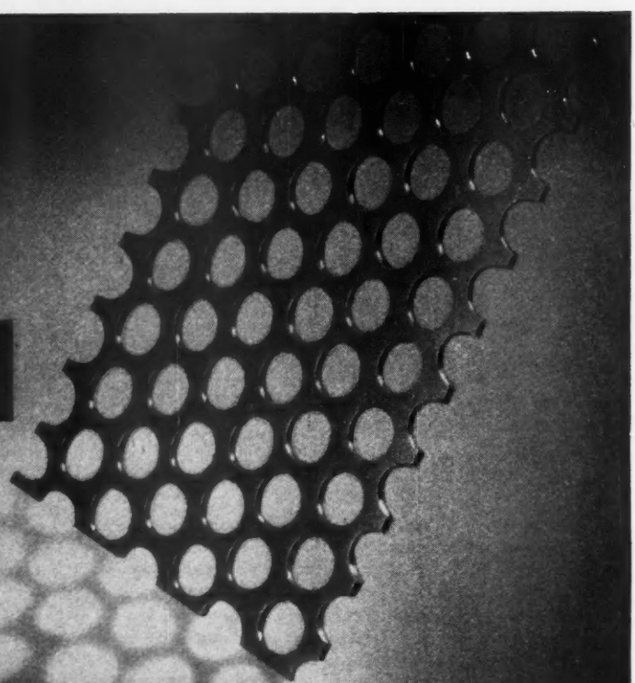

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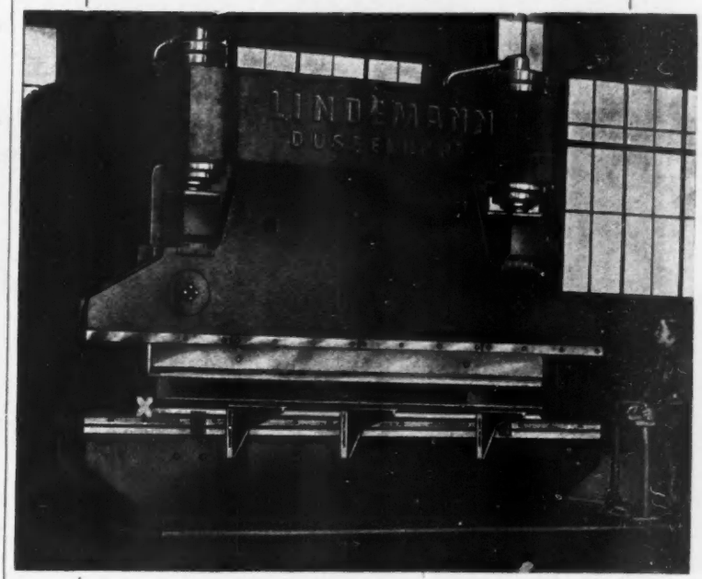

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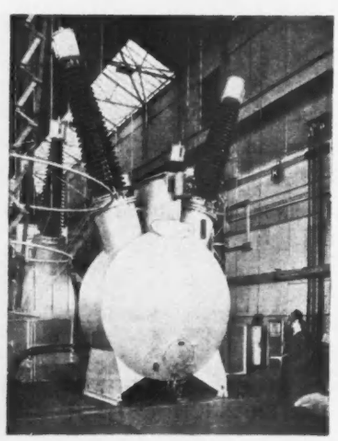

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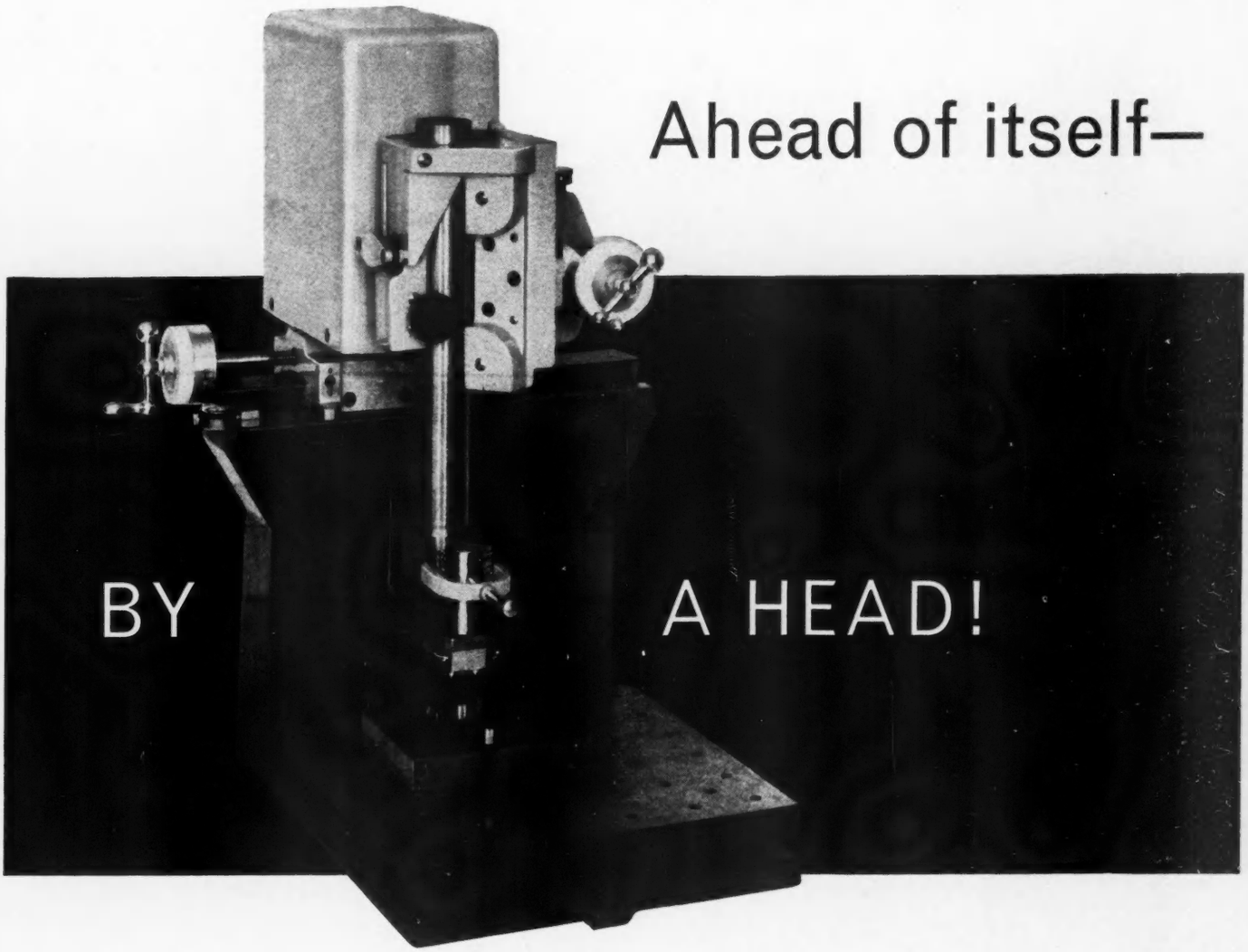
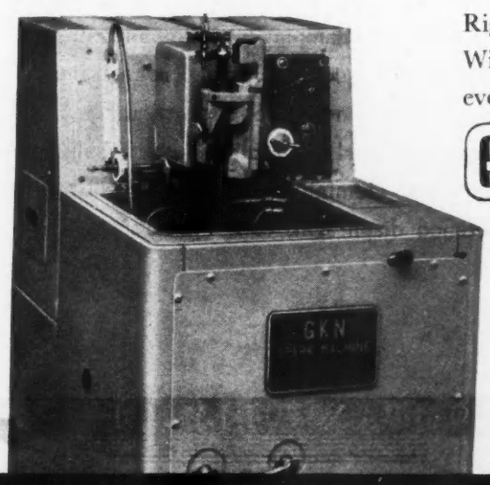


Ahead of itself— BY A HEAD!

In addition to the Fixed Head Model of the G.K.N. Spark Machine, which has already proved so successful, the new Co-ordinate Head Model illustrated is now available. The Co-ordinate Head considerably widens the scope of the machine, by making possible the traversing of the Head without altering the position of the Work Piece.

The G.K.N. Spark Machine makes short work of precision die-making. Over a hundred of these machines are in use in Britain alone, cutting difficult materials into intricate shapes —accurately and fast. Materials like hardened steels and tungsten carbide. Speeds impossible to attain by other methods. Finishes requiring, very often, no further work before use.



Right from the start, the G.K.N. Spark Machine was ahead of anything comparable. With the introduction of this new Co-ordinate Head Model, it has now excelled even itself!

GKN spark machine

DESIGNED BY THE GKN RESEARCH LABORATORY

Manufactured by

WELSH METAL INDUSTRIES LTD. Caerphilly, Glamorganshire.

Sales Agents: M. C. Layton Limited, Abbey Wharf, Mount Pleasant, Alperton, Wembley, Middx.
Rudkin & Riley Limited, Cyprus Road, Aylestone, Leicester.

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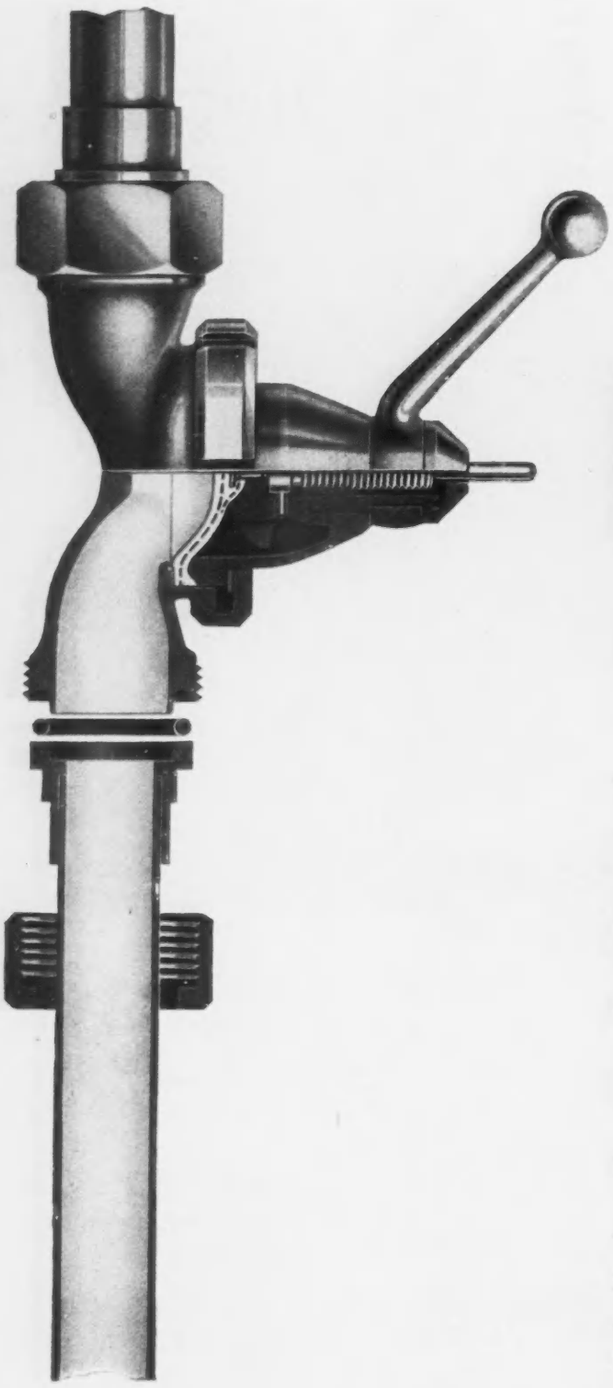

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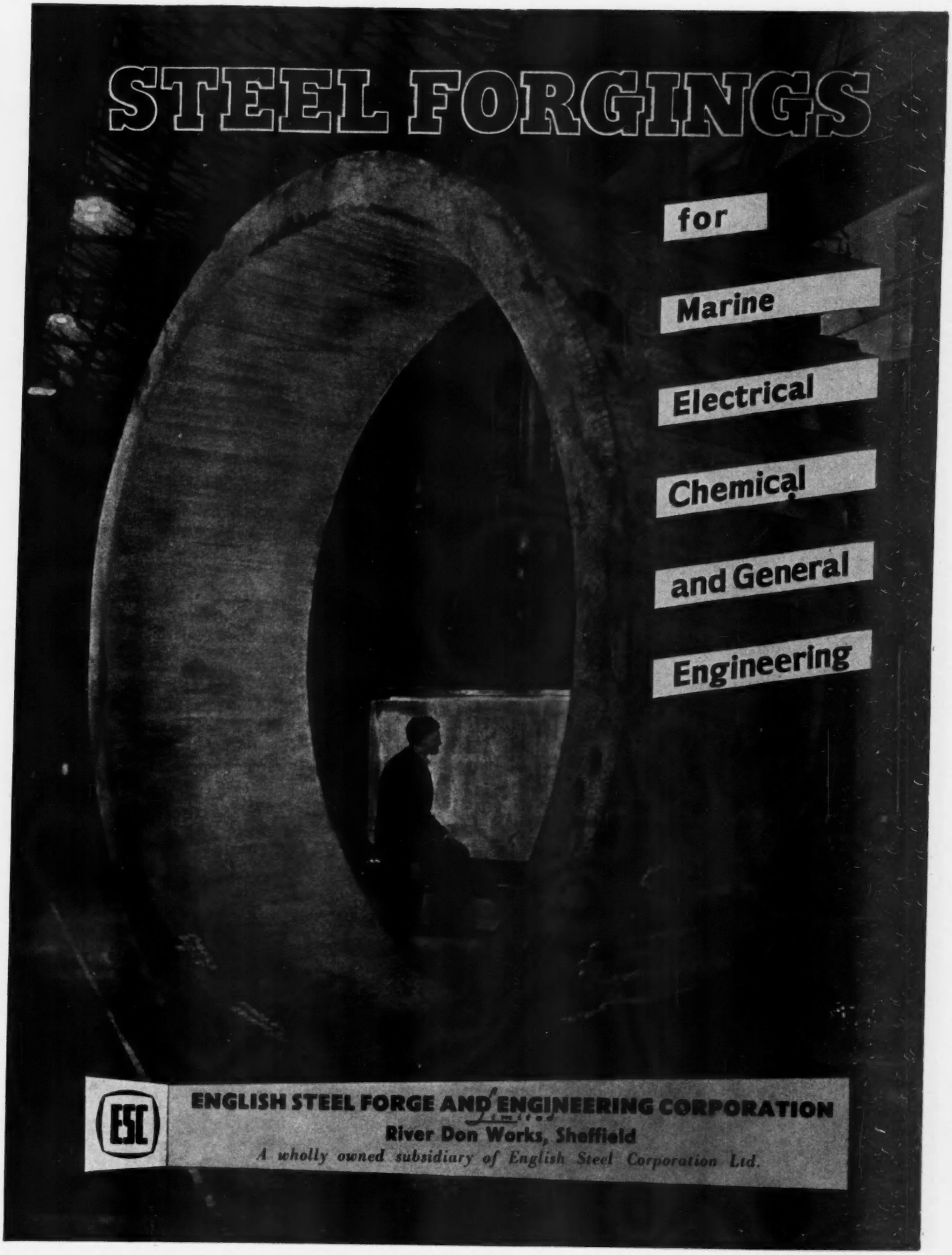
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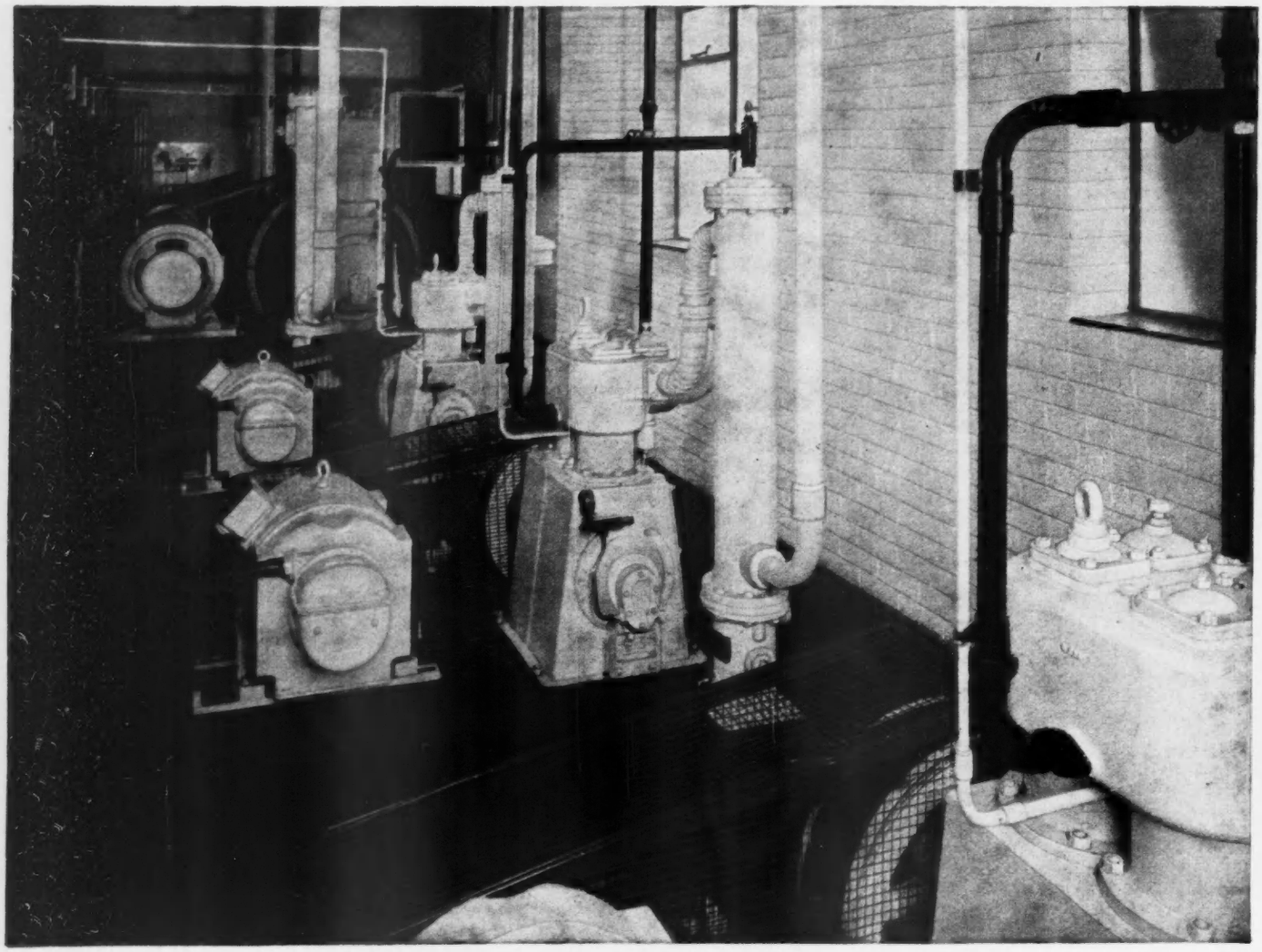

Illustrated is part of a battery of five "Broomwade" stationary air compressors at the Derby Works of H & F Precise Castings Ltd.

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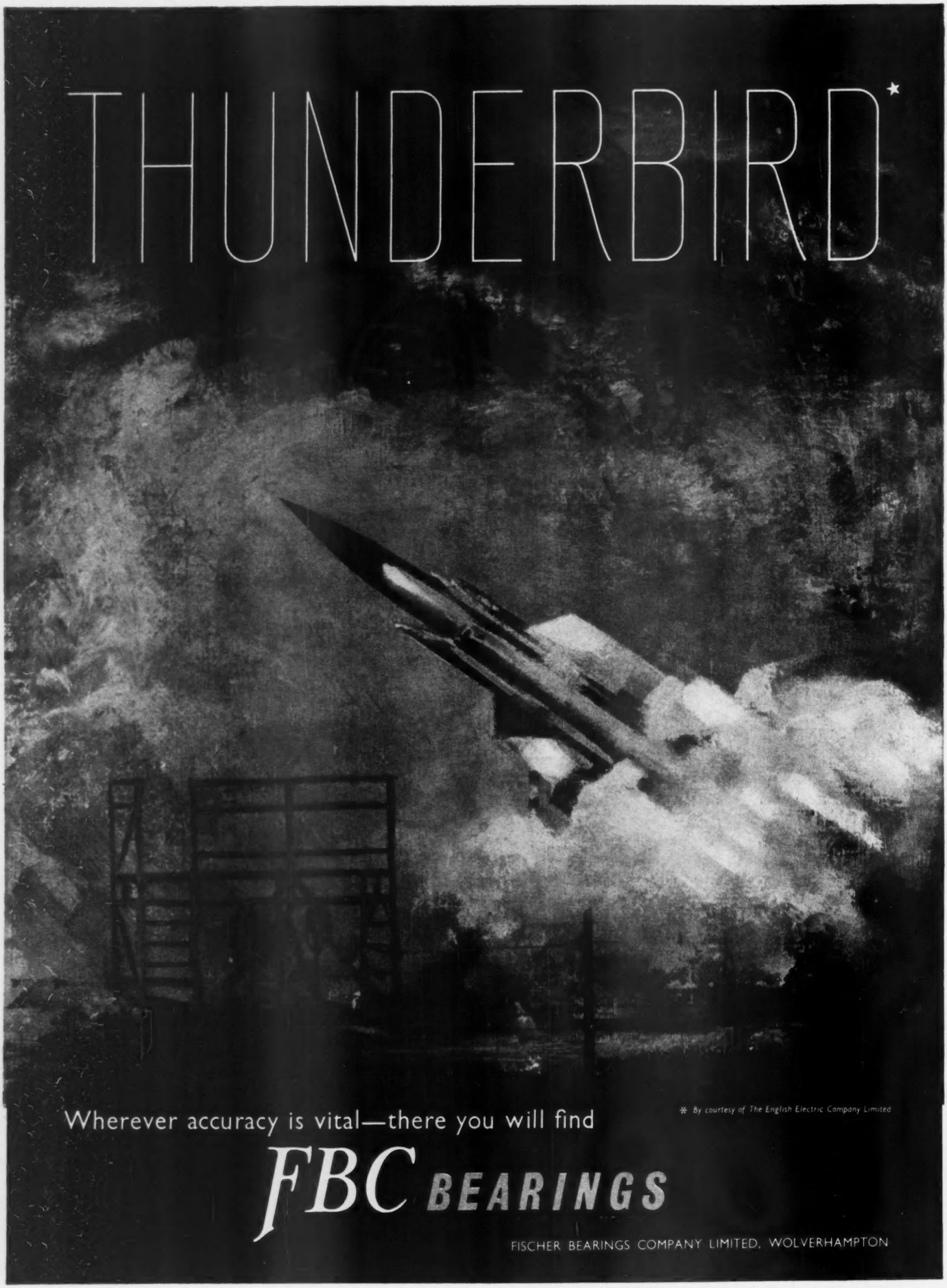

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* By courtesy of The English Electric Company Limited

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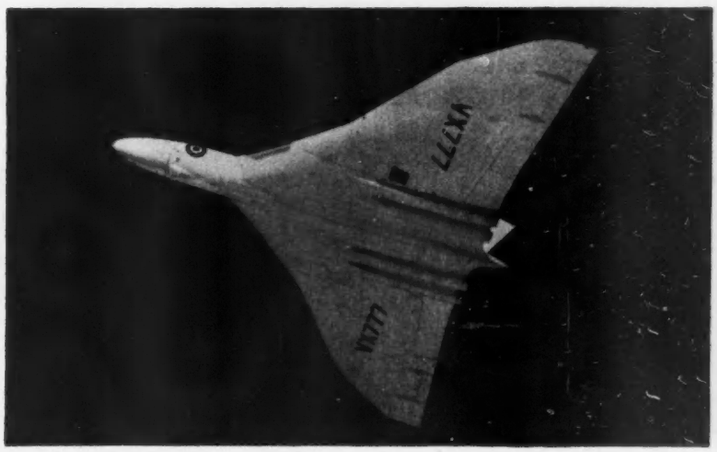
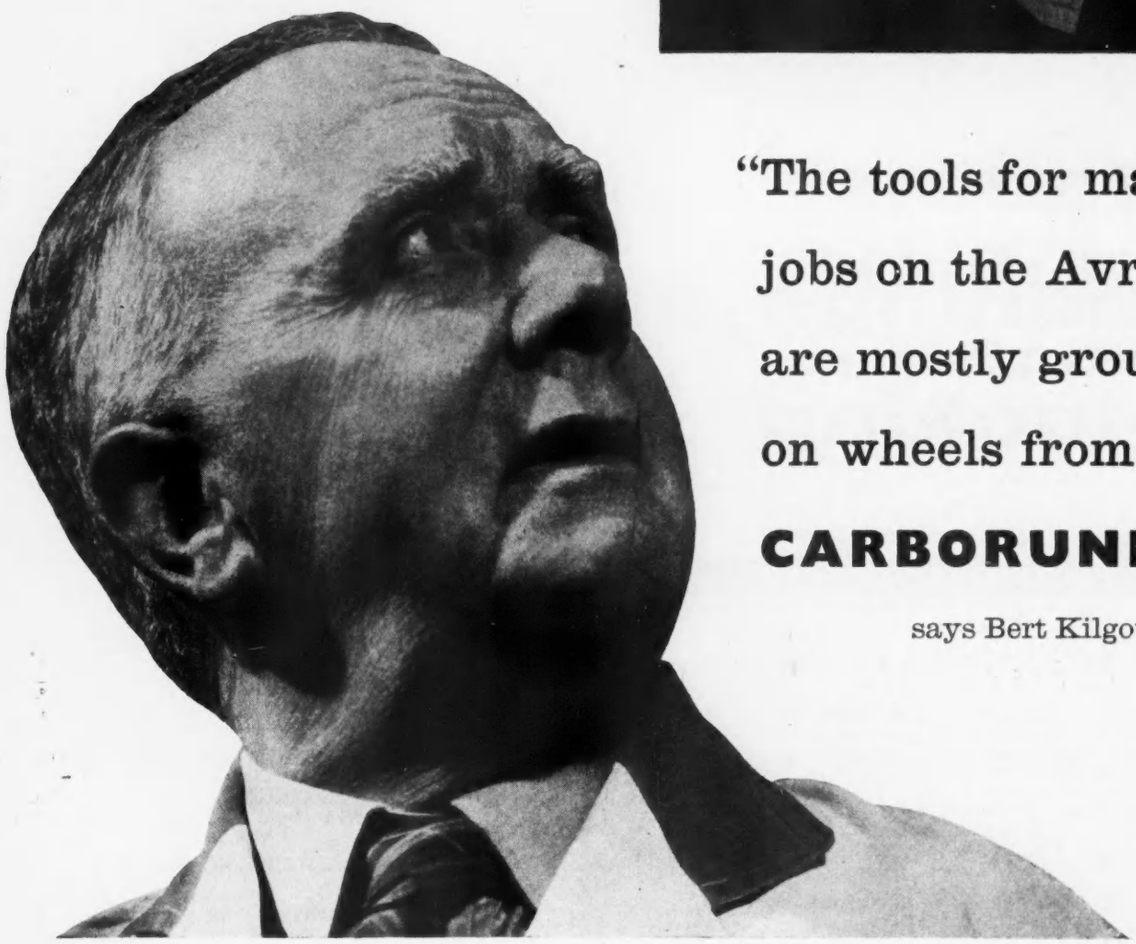
CUSTOMERS OF CARBORUNDUM

Bert Kilgour has worked at the main factory of A. V. Roe & Co. Ltd, at Chadderton, for 40 years, and is now the senior foreman of the toolroom, in which 300 men are employed: "Must be one of the biggest toolrooms in the country", Bert says. "We started getting grinding wheels from CARBORUNDUM in 1936, and they've supplied most of our wheels ever since then. That's for the whole factory—not just the toolroom. Why? Well, because their wheels do a good job, and give us good service. They've always been ready to help us when we've asked them to."





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says Bert Kilgour

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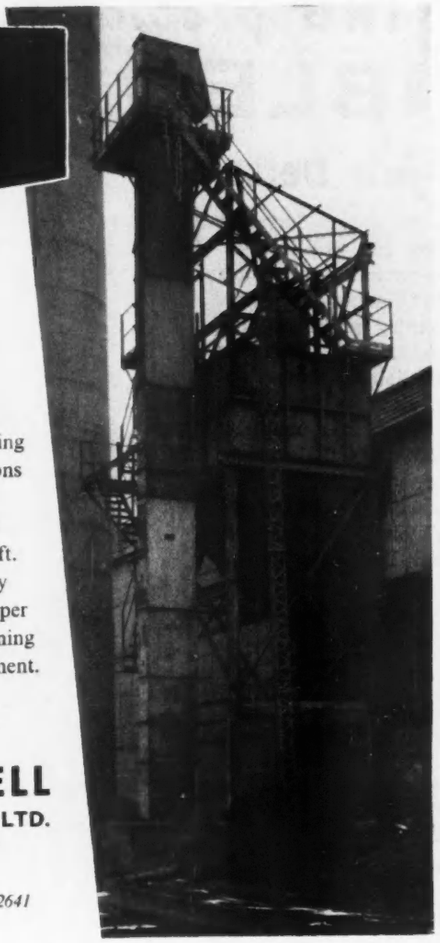

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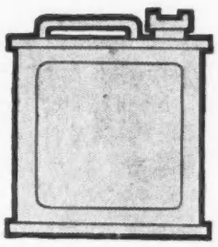

From a can of

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to a tanker of

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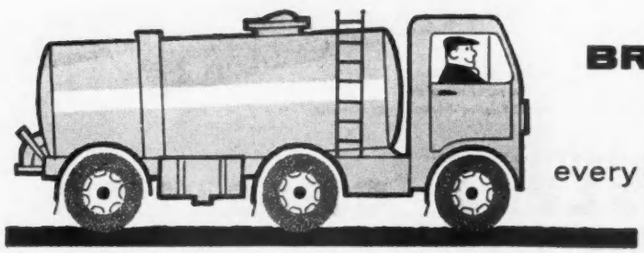

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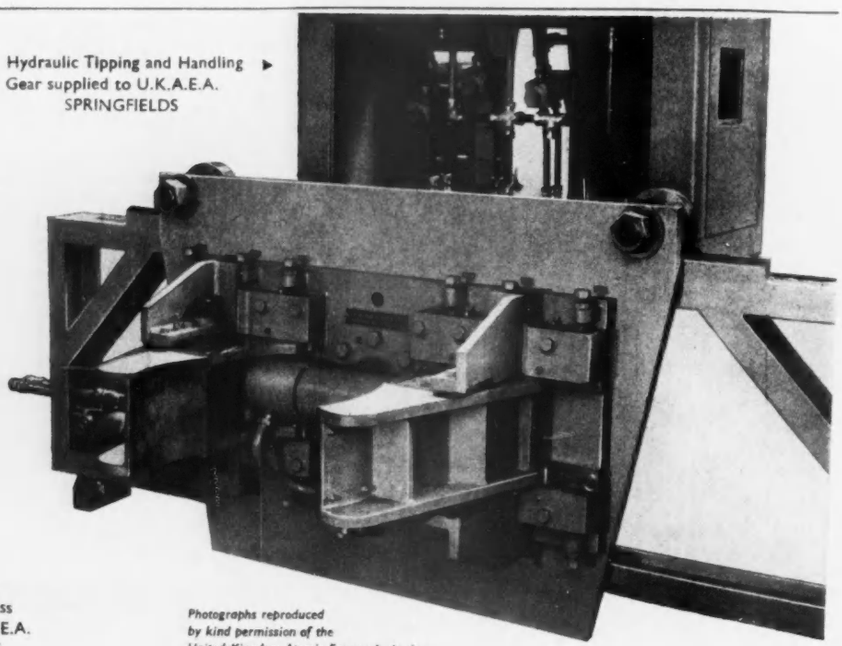

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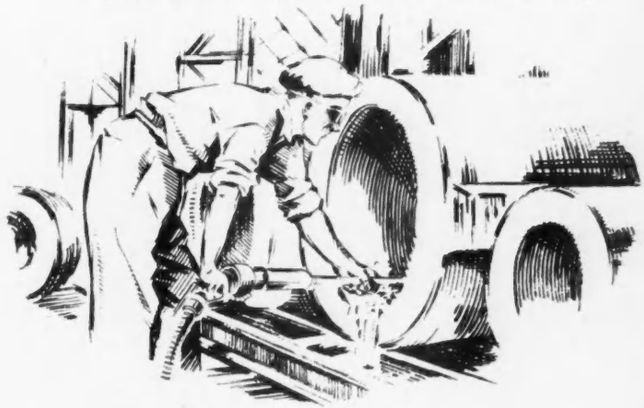

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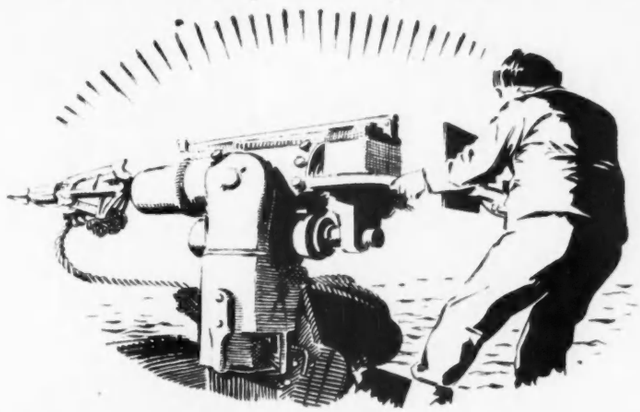

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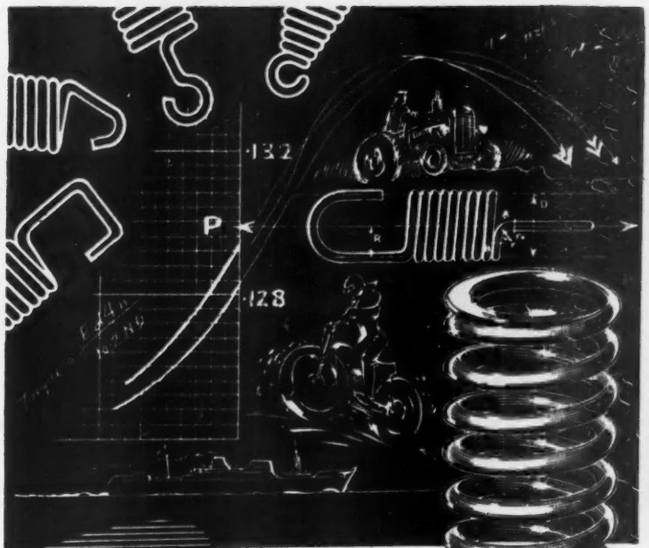

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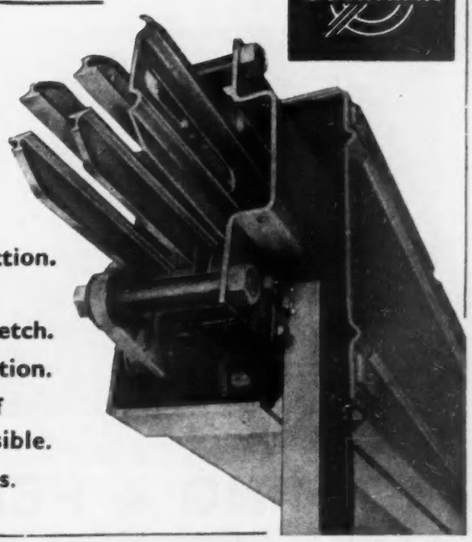

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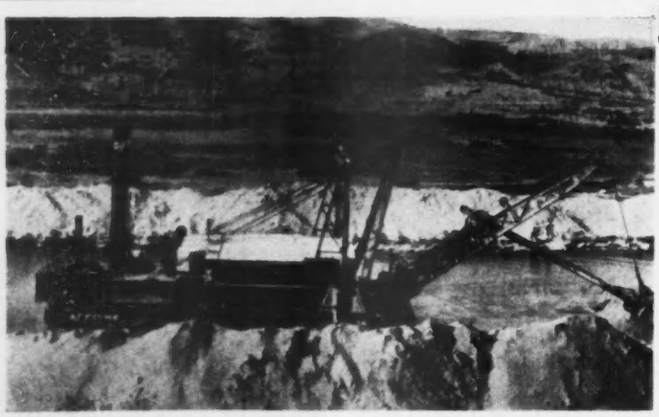

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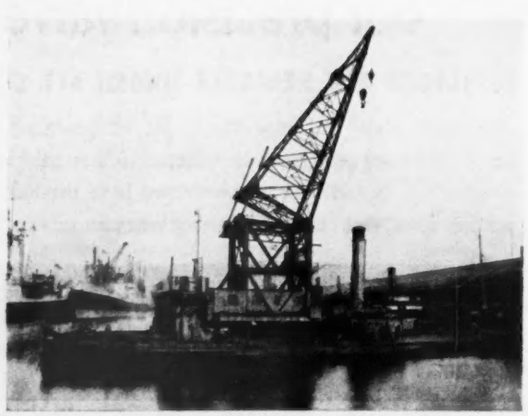

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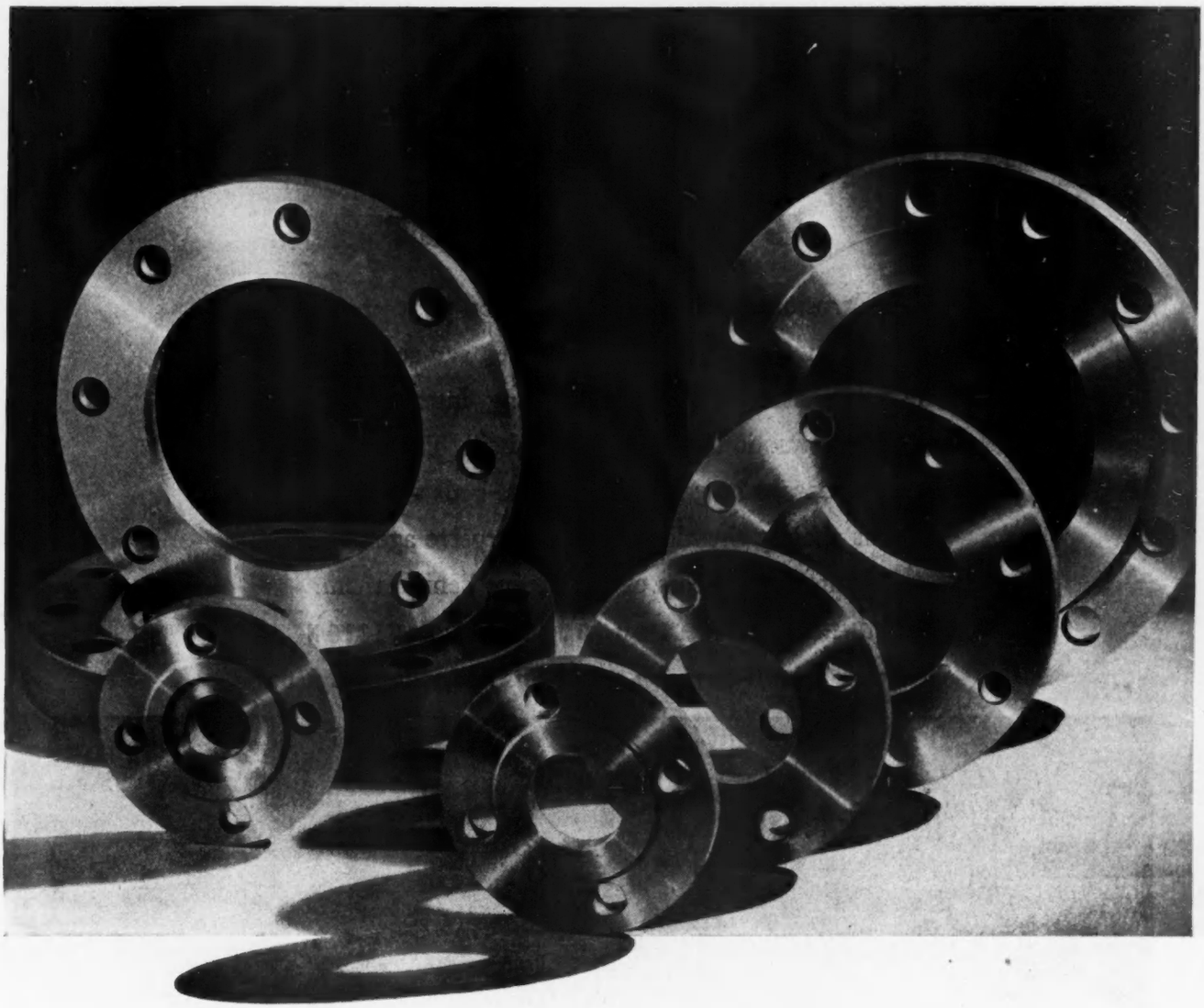

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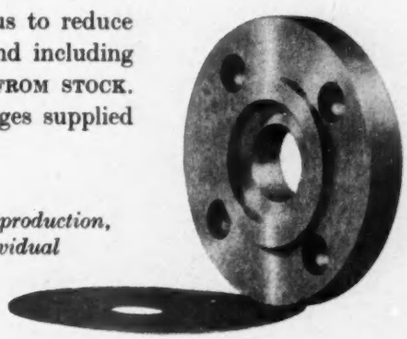

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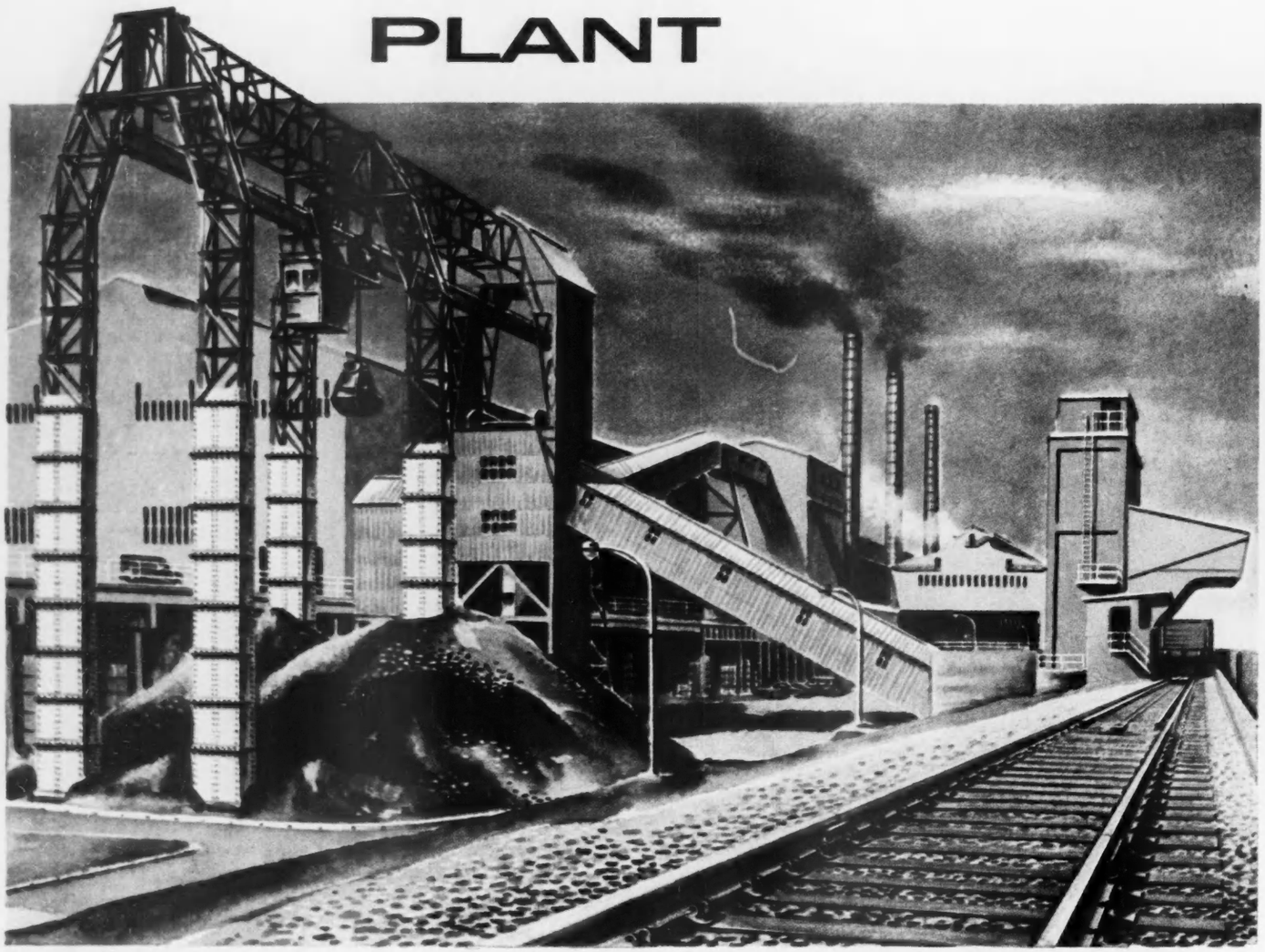

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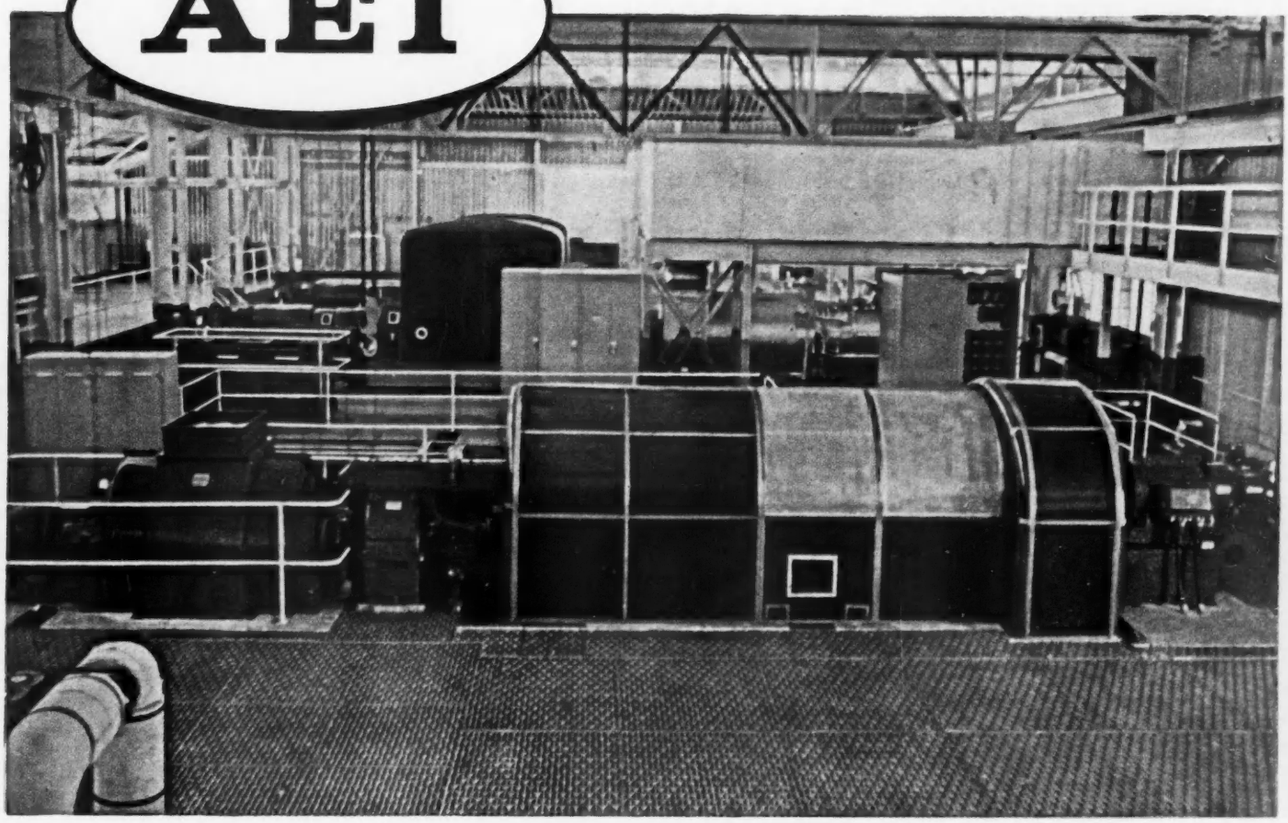

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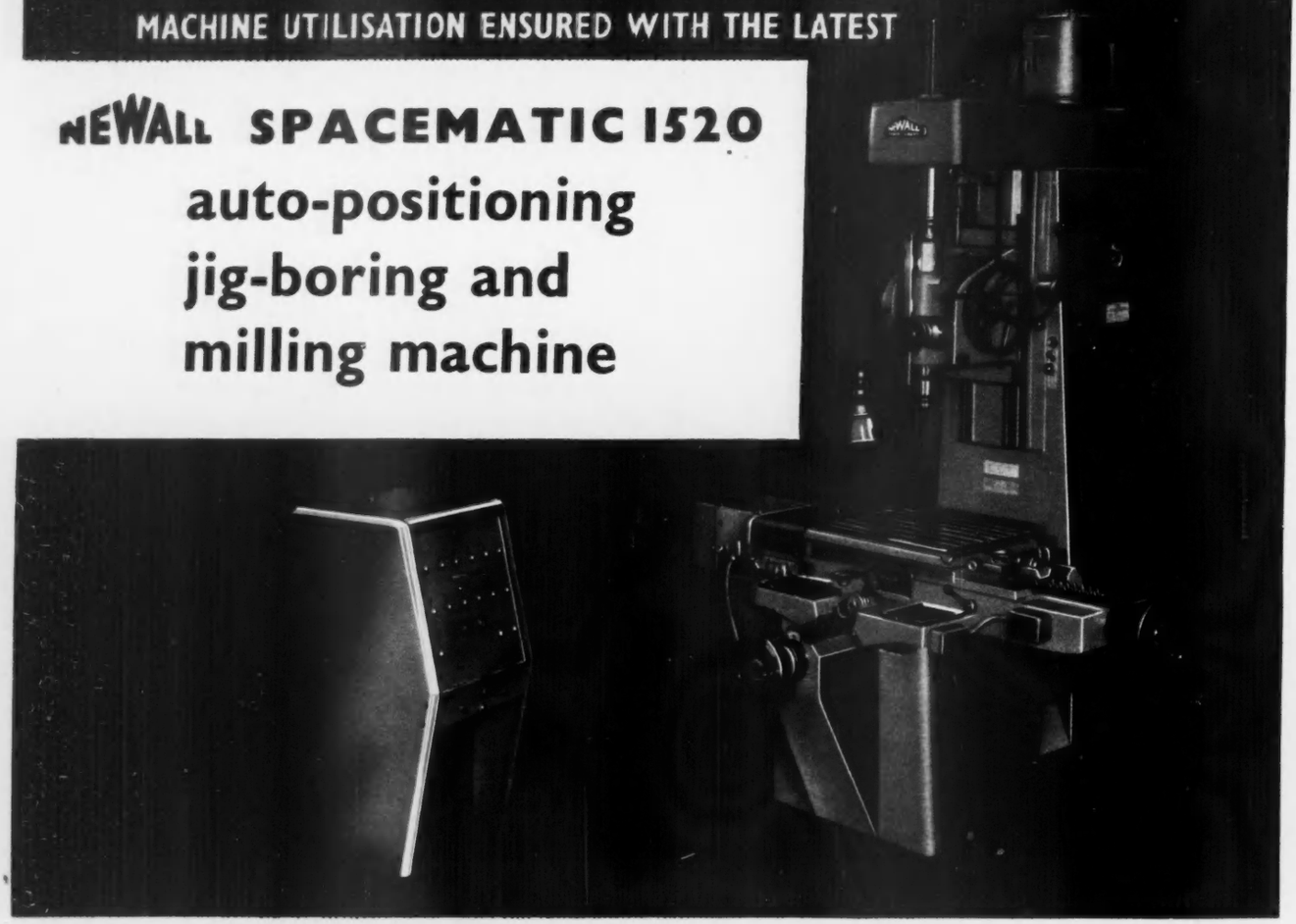

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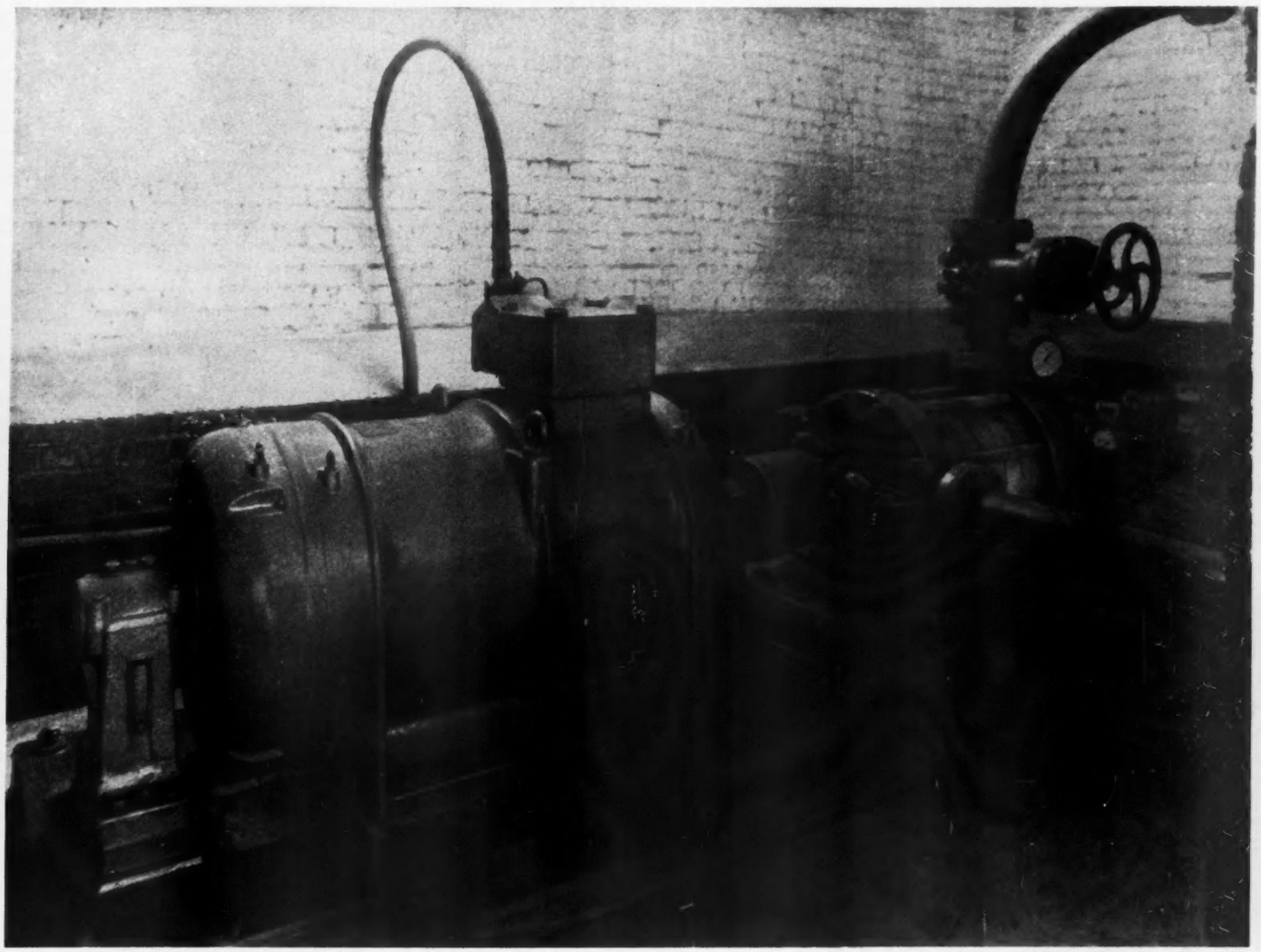

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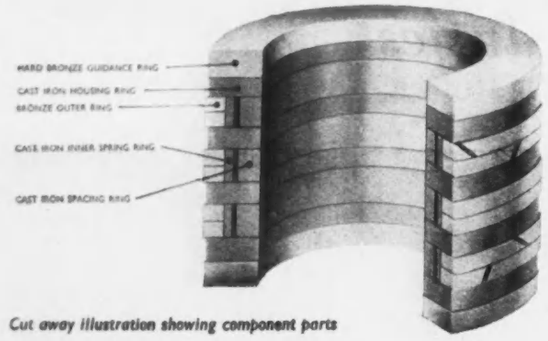

Cut away illustration showing component parts

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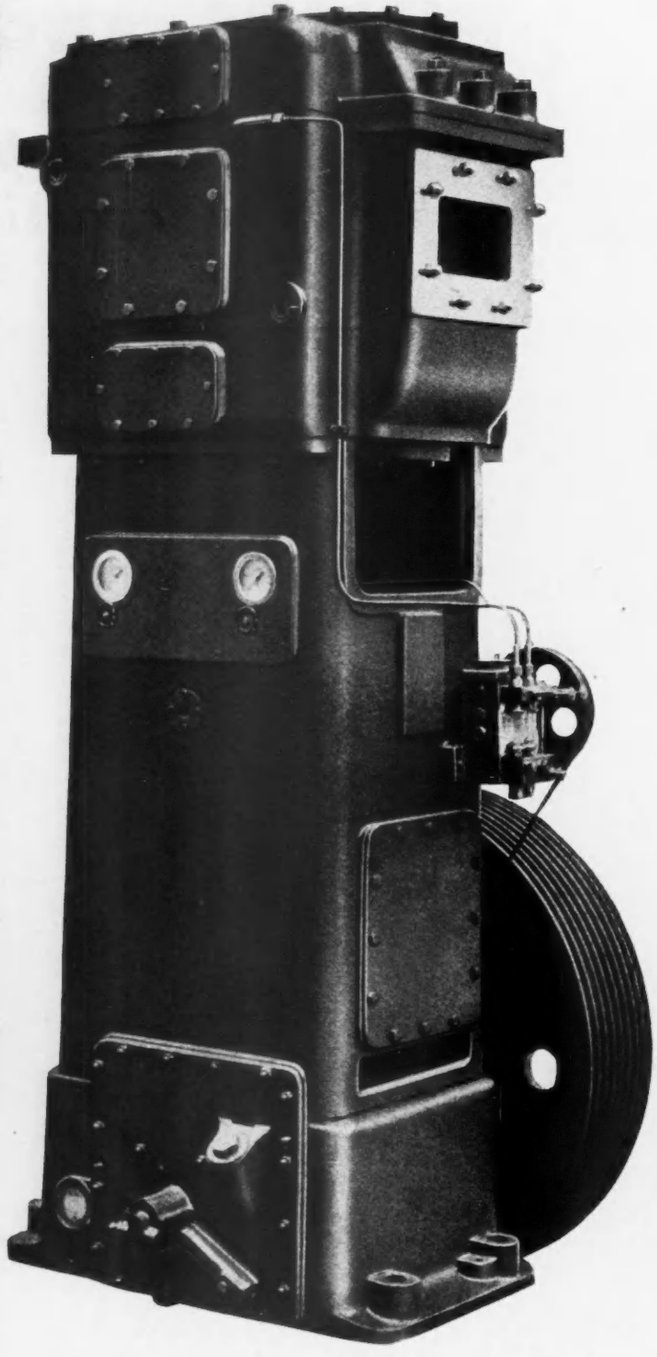

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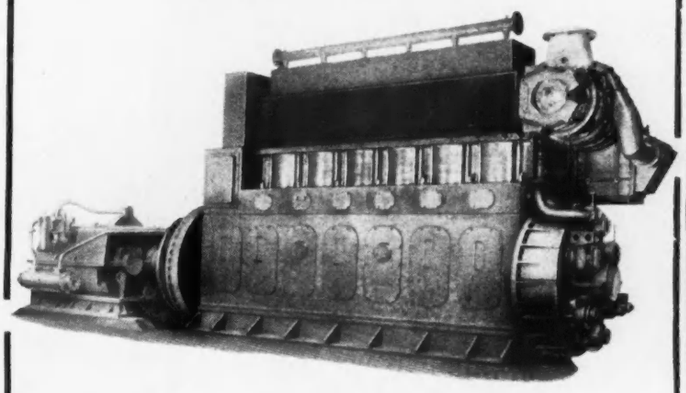

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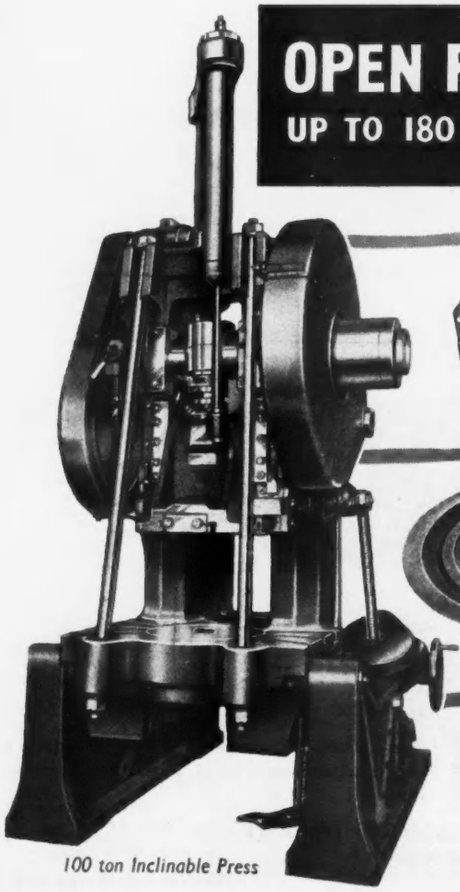

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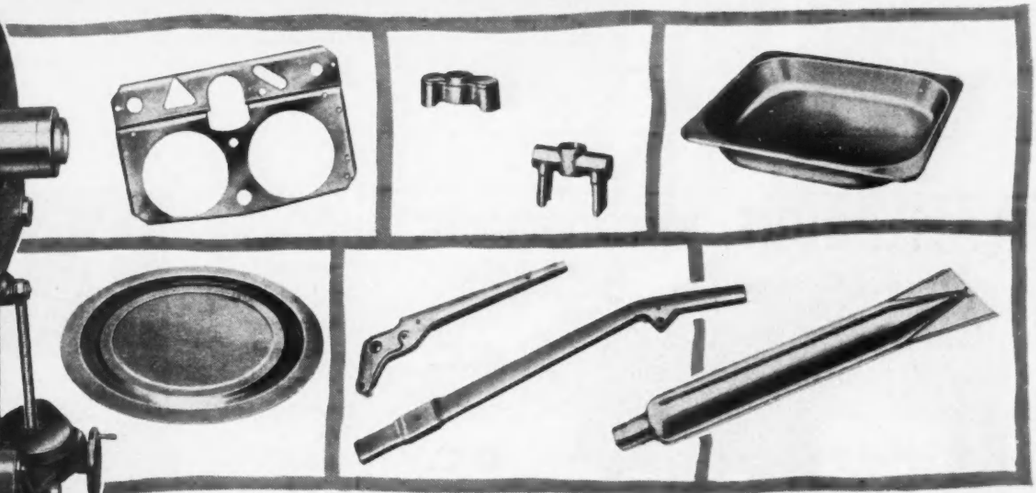

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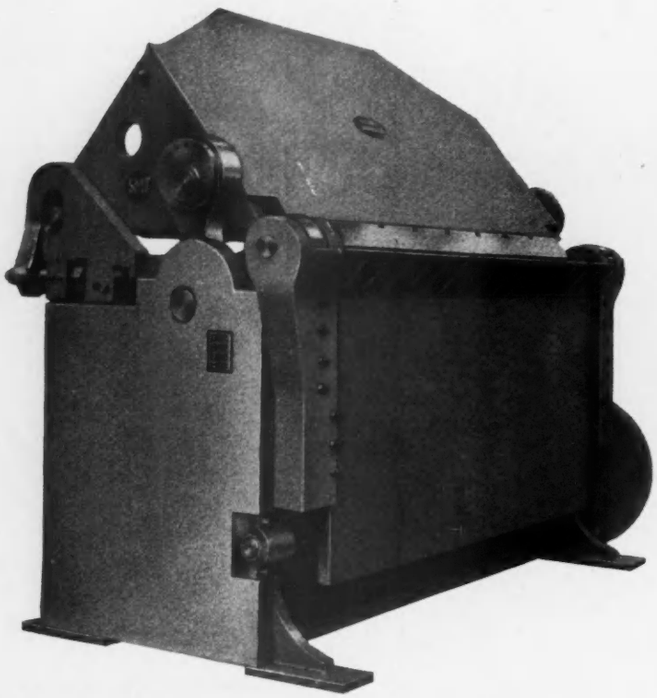

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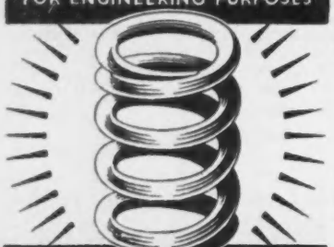

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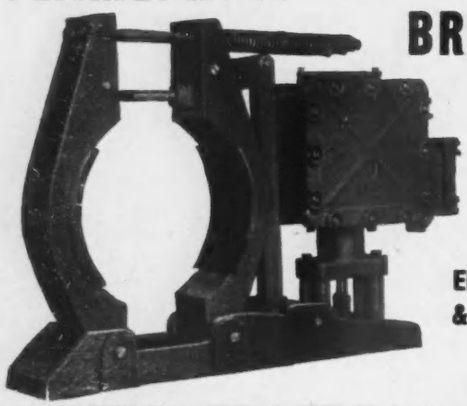

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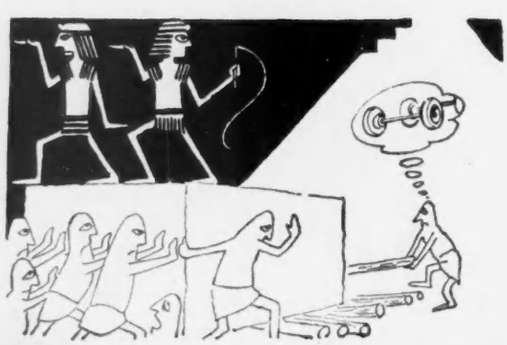

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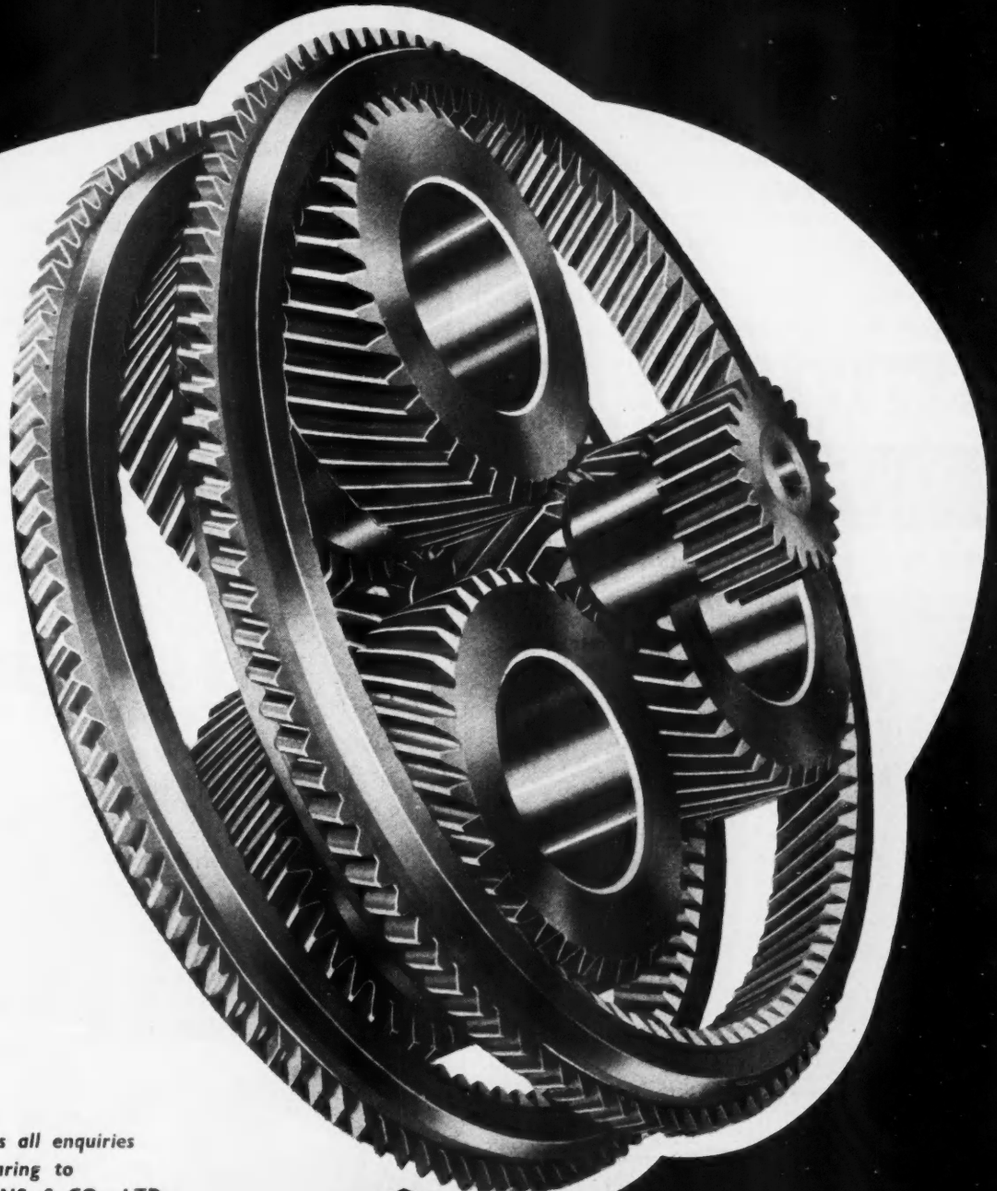

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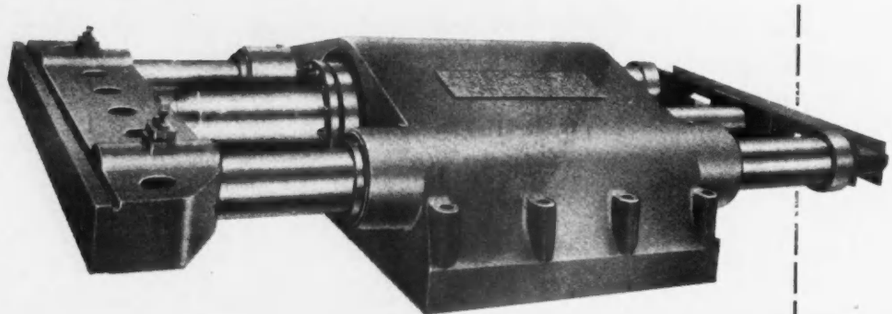

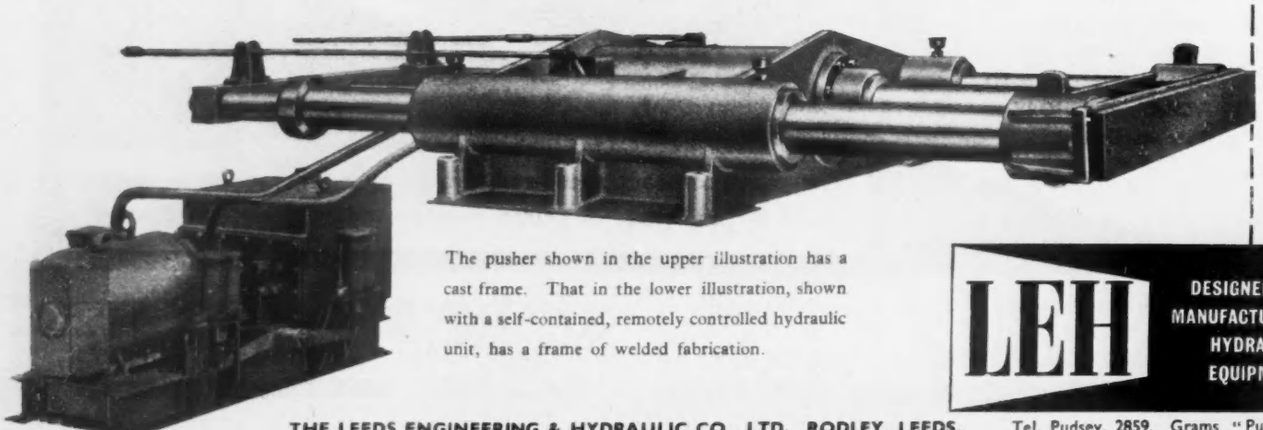

The pusher shown in the upper illustration has a cast frame. That in the lower illustration, shown with a self-contained, remotely controlled hydraulic unit, has a frame of welded fabrication.

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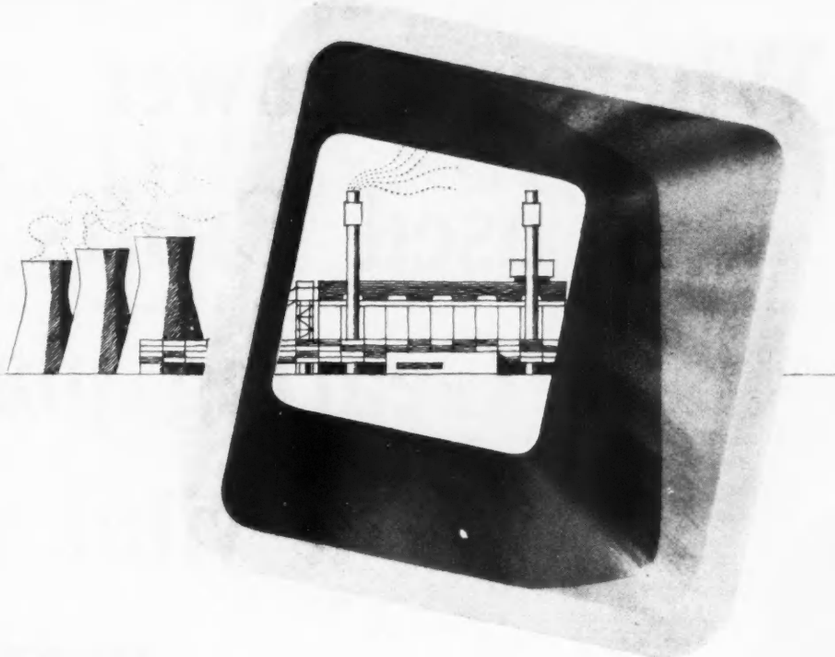

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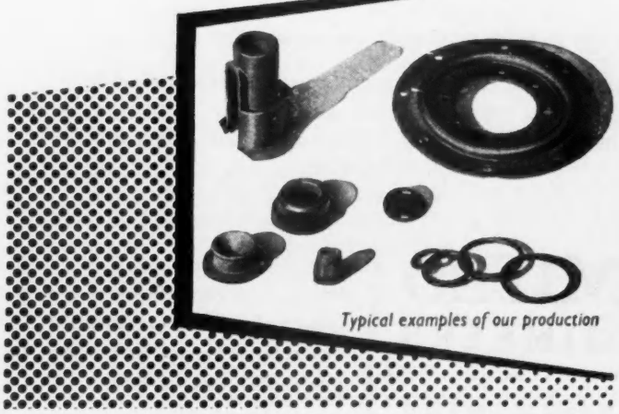

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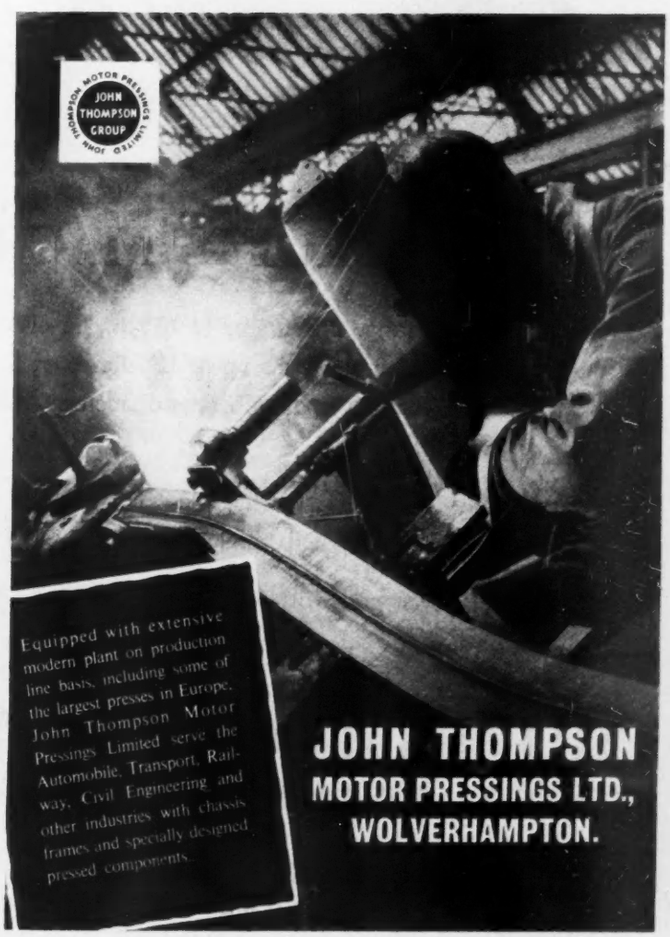

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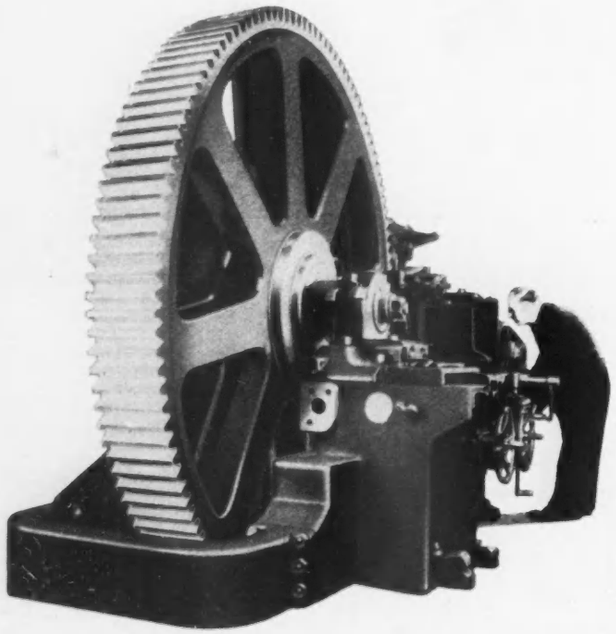

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THE ENGINEER

No. 5411 OCTOBER 9, 1959 VOL. 208

THE ELECTION

When this issue appears the result of the general election will have been decided but it will not yet be known ; for counting of votes will still be in progress. As we go to press, eve of the poll activities are going on up and down the country. How, we wonder, therefore, as we write these words, will the voting go ? Interestingly, the public opinion polls, which in the past have provided reasonably accurate prognostications, have tended in the last few days to provide less and less reliable information. They have shown, indeed, how the early lead of the Conservatives has been whittled away ; but the proportion of " don't know " answers, instead of dwindling away as polling day approached, unexpectedly expanded. Did people really not know, we wonder, or did a proportion of voters deliberately decide to conceal their intentions ? At any rate the proportion of " don't knows " so far outweighed the difference between the numbers declaring their intention to vote one way or the other that the issue remained much more in doubt than usual until the votes were actually cast. So substantial were the numbers of " don't knows " that no outcome of the election can be regarded as surprising ; a landslide in either direction, a stalemate, or any other result seems almost equally possible, though bookmakers seem to regard the chances as favouring the Conservatives ! Like everyone else we have been guessing. Our guess is that there will be another election within a couple of years, that is, that the result of the present election has proved to be almost a stalemate. But we have put no money on it !

THE BACK OF THE MOON

It may be that quite soon there will be issued by the Russians photographs of the back of the moon, that part of the moon's surface which can never be seen from the earth. For last Sunday, the Russians announced that a rocket had been fired and that an object, termed " Lunik III " had started on a journey which would take it round the moon and back again to the vicinity of the earth. The approach to the moon was not expected to be very close. " Lunik III " is reported to have actually passed it at a distance of some 4000 miles soon after 2 p.m. (B.S.T.) on Tuesday. As we go to press, it is still not quite certain that complete success has been achieved as the object is still in the vicinity of the moon and may or may not be on its way back earthwards. The impression appears to be that it will not approach within 1000 miles of the earth's surface. Aphelion of its eventual orbit may lie over 1,000,000 miles away.

" Lunik III " weighs only 613 lb as compared with 858·4 lb for the instrument capsule of " Lunik II," which secured a direct hit on the moon on September 13. It took a little longer to reach the vicinity of the moon than " Lunik II." The reason, no doubt, was that whereas " Lunik II " was launched at a velocity equal to, or greater than, that of escape from the earth, " Lunik III " may have needed to have a rather lower velocity equivalent to that of an object pursuing an eccentric orbit around the earth, whose aphelion lies at a distance from the earth only a little greater than that of the moon. The Moscow announcement referred to the use of a radio link to control the elements of the orbit of the object as it circled the moon and returned earthwards, whatever that may mean. Possibly there are auxiliary rockets on the device which can be fired by radio control to correct the orbit if necessary. If so, a step has been taken towards the setting-up of an artificial satellite of the moon, because any such object would have to be fitted with retro rockets to slow down its motion as it approached the moon, so that it could be captured. Earthbound tracking equipment and computer gear must have been developed to a high order of efficiency, too. " Lunik III " is transmitting signals on frequencies of 183.6 and 39.896 megacycles. As the necessary power is reported to be derived from solar batteries, transmission may continue indefinitely. Presumably it is equipped to make certain scientific measurements besides photographing the far side of the moon. If so, it should be able to provide substantially more information than did " Lunik II " if only because it will spend more time, while still able to transmit or store information, in the vicinity of the moon. It rather looks as though " Lunik II " was sent to the moon to gather certain essential information before " Lunik III " was sent on its way. For, whereas last Sunday the moon was at its closest to the earth for the month, it was further away in mid-September. If so, presumably " Lunik II " gave the desired information.

What will the other side of the moon look like ? It will be very surprising if it differs at all in general character from the side visible from the earth.

THE PRICE OF AMENITY

Because electricity is so easily and widely available, without any fuss, day and night, at the flick of a switch, its value as an amenity tends to be taken for granted. The public is happy to accept this service as a right but it is much less ready to accept the plant that provides it. To an increasing extent, the design and siting of power stations and transmission lines are criticised on the grounds that they spoil the countryside and its amenities. Now it is well that the public in this small, densely-populated island should be jealous of its rights to preserve the beauty of the countryside, but those who are most zealous to exercise these rights are not always thorough enough to acquaint themselves with the facts.

Some of the facts that must be accepted if the subject is to be seen in perspective were forcibly stated by Sir Christopher Hinton at a recent Press conference. Sir Christopher asserted that the Central Electricity Generating Board was becoming increasingly concerned with the question of the relationship between amenities and the siting of power stations and transmission. Under the Electricity Act of 1957, the electricity supply industry is responsible by statute (instead of voluntarily, as hitherto)

for taking into account the effect of its development proposals on " the natural beauty of the countryside and other amenity aspects." Proposals for building power stations and overhead power lines are subject to the consent of the Minister of Power and an elaborate (and usually protracted) procedure is followed to ensure that all who are likely to be affected by a project are made aware of it and are given the chance to state their objections. A great deal of time is spent in exercising these public safeguards. In planning transmission lines, for example, it is common practice, nowadays, for the supply industry to submit proposals five years in advance, allowing as much as three years for the procedure towards the Minister's consent and two years, or less, for the actual construction. For example, as Sir Christopher pointed out, the 275kV overhead line which will form part of the cross-channel cable link between the English and French power systems is still held up after more than two years of negotiation. As a result, this power link is likely to be a year behind schedule. One outcome of this delay, he stated, was that British manufacturers were losing valuable experience and, possibly, exports. Another possible consequence was that electricity supply to East Kent might be jeopardised in the winter of 1960–61.

In the case of transmission systems, the usual remedy suggested is to install underground cables instead of overhead lines. It would be an expensive solution for, as Sir Christopher reminded us, the cost of laying cables would be seventeen times that of building an equivalent overhead line. If it were applied on a widespread scale, underground transmission would increase the bulk supply tariff by 15–20 per cent. Such would be the cost of dispensing with overhead lines. An expensive amenity, we think ! A more realistic approach, surely, is to accept transmission lines and the power stations at the end of them as part of the modern scene. There is scope, perhaps, for a fresh objective approach to the problem of designing and siting transmission towers and lines as functional yet harmonious parts of their surroundings. This harmony has been achieved, whether by chance or design, in places like the Alps, where the sweeps of catenaries and the towers that carry them, please the eye without offending the senses, by suggesting something of man's attempt to come to terms with his environment. A similar effect may be more difficult to achieve in a country like Britain, where the scale of the countryside is smaller and the appeal of the scenery more subtle. But the problem presents a challenge that should be welcomed alike by the engineer and by those who are so ready to criticise his efforts.

BRITAIN'S FUTURE NAVY

If the Air Ministry had been obliged to charge to Royal Air Force votes the large sums required in the post-war years to finance the research and development of jet propulsion it is unlikely that Britain would have had the first-rate " V "-bombers and fighters in service to-day. A new form of propulsion now under development—nuclear propulsion—is required more urgently for fighting ships than for military aircraft. Why then should the research required be financed by Navy votes ? It is true that this nation is now able to benefit from the technical knowledge and experience acquired by the United States and that the nuclear plant and propulsion machinery for the first British nuclear-propelled ship, the submarine " Dreadnought," are being purchased from that country. But it is surely both unnecessary and undesirable that the navies of the two nations should be rebuilt with vessels of the same size and type. Aircraft carriers of 70,000 tons, costing over £100 million, and giant submarines of 5400 tons, costing £36,000,000, for use primarily or solely as a deterrent, are but two examples of the kind of ship this country cannot afford nor needs to build. Much research and development will be required, both in relation to the nuclear power plant for each class of ship and improvements in filters, pumps, valves, bearings, auxiliary machinery and other conventional components of the plant. Is it reasonable that the cost should be charged to Navy votes when the ships themselves nowadays are so expensive to build ?

The question is of major importance now that the last of Britain's large ships, all laid down during or before the war, are about to be completed—the 22,000-ton carrier " Hermes " this year and the " Tiger " class cruisers, " Blake " and " Lion," in 1960. When the current defence plan has run its course in 1962, it will be essential to begin a naval building programme unless this country is to rely on the United States Navy to safeguard its merchant ships in the wide oceans. The Royal Navy will then have seven front line carriers, and only three (" Tiger " class) cruisers of real fighting value to protect them from surface ship attack and assist them in safeguarding the sea routes. Ten more wartime cruisers have still to be scrapped and they should be replaced by a squadron of at least four powerful vessels of cruiser type to provide one protecting cruiser for each carrier. Another urgent requirement is a flotilla of fast nuclear-powered " hunter killer " " Dreadnought " submarines as the most effective counter to the large missile-launching underwater vessel. Apart from relieving Navy votes of the cost of research and development required for the construction of nuclear plants and propulsion machinery, there seems only one solution to the problem of financing a naval building programme, while still contributing to the Allied deterrent, with a maximum defence budget of £1500 million. The new cruisers must be built to carry out a dual role and be partly armed with ballistic rockets as Britain's share in making an improbable war still more improbable. As already pointed out in these columns, the solid-fuel naval ballistic rocket " Polaris," as now developed for the United States Navy, is a relatively small missile, only 46ft in length. But the Americans are satisfied that, with further development, it will have a range of 1500 miles and a warhead large enough to compensate for the inherent inaccuracy of the ballistic rocket. With a range of 1500 miles, launched from the vicinity of an enemy's coast, it could reach every worthwhile target. In developing the land-based " Blue Streak," with its costly underground site, Britain is having to earmark a substantial and growing share of the defence budget for what is in fact a fourth arm of defence—her share of the Allied deterrent. It may be a first-rate weapon and there is no doubt that its underground site will give it reasonable safety from ballistic rocket attack. But the destructive power of the " H "-missile continues to grow. It is already 1,000,000 times more destructive than the biggest " Grand Slam " bomb.

The best protection for rocket bases is to make them mobile, that is to put them in ships. The country cannot afford £36,000,000 for the ideal base—an underwater vessel—since the primary task of every ship in the Royal Navy is, directly or indirectly, to control the sea communications, and a rocket launching submarine could only be of use as a deterrent. But surface ships are equally mobile and thus equally safe from ballistic rocket attack. In his book, *The World Crisis*, Sir Winston Churchill, referring to the danger of a torpedo attack on the Fleet in 1914, reminds us that of all the dangers which menaced the British Empire, none was comparable with a surprise attack on the Fleet. The Fleet found its safety in mobility, just as mobility is the only

sound protection for the deterrent base to-day. Unlike a heavy gun, a ballistic rocket requires no armoured turret or strengthened decks, although complicated machinery might be needed to operate it satisfactorily from the unstable platform of a ship at sea—a problem that could be overcome were the vessel designed to withstand beaching. If the "Polaris" rocket were supplied by the United States under Mutual Aid, it should be financially practicable year by year to replace all Britain's large vessels, both aircraft carriers and cruisers, with nuclear-propelled ships. The Royal Navy would then have modern ships better prepared to deal with a limited war overseas or, at the worst, a more serious conflict arising from it and fought mainly at sea.

COAL IN INDUSTRY

The National Coal Board is taking various steps to encourage British industry to maintain and extend its interest in coal. These steps were expounded at a press conference last week by Mr. R. H. E. Thomas, the Board's marketing member, who said that the principal objective was to restore some of the "lost lustre of coal in the public eye." The Board is understandably concerned about the increasing use of oil fuel by general industry and, understandably, it must strive to regain some of the ground that coal has lost in the past two or three years. To accomplish this, the Board intends to provide an improved and comprehensive technical and general sales service and to publicise industrial coal (mainly in the "tycoon" Press we were informed) in a way which will offset the feeling that oil is the fashionable fuel. In this publicity campaign, emphasis is to be given to individual coal-burning installations which are operating at high efficiencies. To support its propaganda plans, the Board has commendably reiterated its determination to improve the quality and consistency of the coal it offers. Mr. Thomas recalled that, since nationalisation, 261 new coal preparation plants had been built, between £25,000,000 and £30,000,000 a year was being spent on cleaning and preparing coal for the market, and about £10,000,000 was being invested annually in new mechanical cleaning plant. Hand-cleaning, he added, was being eliminated for all but large coal above 6in to 8in in size and research in coal preparation was being carried out. Every effort was thus being made, Mr. Thomas declared, "to give the consumer the coal best suited to his particular purpose."

From the industrial user's point of view, it would appear that the best incentive the Board can offer is better quality coal at the prices now ruling. The general level of coal prices has remained stable since the middle of 1957 and the Board's hope is to maintain that stability unless circumstances completely beyond its control arise. The one thing which the Board cannot determine with any certainty is how much more coal it is likely to sell in the field of general industry. What it does know, however, is that, in the first nine months of this year, industrial coal consumption was 2,000,000 tons less than in the comparable period of 1958 and that, according to the latest statistics, undistributed stocks exceed 33,000,000 tons. The task of the Coal Board's marketing division continues to be a difficult one.

AIDS TO HUMAN RELATIONSHIPS

Every now and then we are invited by the Industrial Welfare Society to investigate some new activity. Some weeks ago for example the Society showed us some new film strips which it has added to its range. In the film-strip technique, it will be recalled, a gramophone is used to tell a suitable story while a lantern projects on to a screen a series of stills printed on film-strip. A "pip" coming out of the gramophone warns the operator to bring the next still into view. In the past a number of such film-strips have been made to assist in the instruction of junior executives. A story is told based on a real life happening. It commonly shows some failure in human relations. After the film-strip has been shown those under instruction are asked to comment and discuss. In the earlier film-strips of this kind the tendency was to record a story in which, more or less obviously, one of the characters made a mistake and the audience was invited to spot the mistake and to suggest what action ought to have been taken. But in three of the film-strips we saw a few days ago there seemed to us to be less emphasis on the mistake. Instead the rather more subtle question the audience was invited to discuss was of the "what do you do now" order. This seems a desirable direction for evolution to take. For no one can wholly avoid making mistakes in the handling of men, nor is it enough to recognise that a mistake has been made. In real life the situation has to be restored, irritation must be removed lest tempers become really ruffled and so on. But how ? Three further film-strips had a straightforward instructional character ; they related to the handling respectively of boxes, drums and sacks. The remainder related to salesmanship, in a shop, and by a firm's representative to a grocer. They made it occur to us that there might be room in this field for a film-strip on engineering salesmanship. Or would engineering salesmen regard themselves as a "cut above" this kind of thing ? It is to be hoped not. For in our opinion higher executives can certainly find something to learn from the Society's film-strips dealing with human relations !

The Engineer—100 Years Ago (OCTOBER 7, 1859)

"Ballooning"

"Among the committees for unpaid inquiry into subjects of scientific interest, named at the final meeting of the British Association, was a committee of which Sir David Brewster and Colonel Sykes are members, to report to the next meeting, at Oxford, on the scientific objects which may be sought for by continuing the balloon ascents, formerly undertaken, to great altitudes."

"Engineering Bravery !"

"The London correspondent of a country paper says—Audacity was one leading feature of Brunel's engineering character. I heard an anecdote which illustrates this strikingly. Brunel held views in contradiction to those of his brethren as to the employment of a peculiar kind of cement in railway-bridge building. Other engineers objected to its use as it hardened too fast to allow the work to settle properly. Not so Brunel. Trusting to his own view, he used this cement in one of the first large bridges constructed by them for the Great Western line. It fell soon after its erection. Brunel entered the room where the directors were assembled, in discomfited conclave, to discuss the accident. 'I congratulate you, gentlemen, on the fall of the bridge,' was Brunel's entry on the subject. 'Congratulate us on an accident involving disaster and the loss of — pounds' was the angry and amazed rejoinder. 'Certainly,' said Brunel coolly, 'I was just about to put up 200 bridges in the same manner.'"

"The Great Eastern"

"It has been decided that the great ship is to leave her present anchorage at Weymouth tomorrow, the 8th instant, to proceed on her trial to Holyhead. No passengers will be conveyed upon the trial trip to Holyhead, and all the persons who have taken berths for the occasion will have their money returned to them."

Nuclear Reactors for Marine Propulsion

No. IV—(*Continued rom page* 851, *May* 29)

In our issue of May 15, 1959, we described (page 754) a gas-cooled graphite-moderated reactor system for marine propulsion submitted by the G.E.C.–Simon-Carves Atomic Energy Group for consideration by the Admiralty. A preliminary design of a smaller reactor suitable for a 20,000 s.h.p. marine propulsion installation has recently been completed by the same group. Reductions in weight, size and capital cost result from improvements incorporated in the new design. The following account is abstracted from a report prepared by Mr. M. C. Hartnell-Beavis, chief projects engineer of the G.E.C. Atomic Energy Division.

THE chosen system should approach modern steam-cycle conditions, with a minimum temperature at the turbine stop valve of about 850 deg. Fah. (455 deg. Cent.). Furthermore, it must offer a clear development potential towards higher temperatures and canning material with a low nuclear cross section.

The gas-cooled system has the advantage that the system pressure is independent of temperature. Stainless steel canning allows a coolant outlet temperature in excess of 1000 deg. Fah. (540 deg. Cent.). The choice of stainless steel was dictated by the necessity of basing present proposals on current technology. There are two attractive alternatives—beryllium and impermeable graphite. The former will be used in the AGR, but while it gives a considerable advantage owing to its low cross section, it offers no improvement over stainless steel in development to higher temperatures. Impermeable graphite has been successfully developed in the G.E.C. Research Laboratories at Wembley. It has remarkably different properties from normal graphite, and in many ways resembles a metal in strength and elasticity. The effects of neutron irradiation are at present being examined experimentally, and preliminary results have been completely satisfactory.

While these advantages of the gas-cooled graphite-moderated system applied particularly to large land-based installations, it appeared until recently that it would be extremely difficult to achieve the high heat-transfer rates necessary for a small marine reactor. The power density in the AGR core is approximately 40kW per cubic foot (1400kW per cubic metre); for a marine installation this would have to be increased to at least 150kW per cubic foot (5300kW per cubic metre). It is of interest to note that the power density in the Dresden boiling-water reactor is about 700kW per cubic foot (25MW per cubic metre), and in the Shippingport pressurised-water reactor about 1000kW per cubic foot (35MW per cubic metre). A new design[1] of fuel element has been developed by the G.E.C./Simon-Carves Atomic Energy Group which makes possible core volume ratings of the same order as those achieved in water-moderated reactors. The choice of about 270kW per cubic foot (9·5MW per cubic metre) at 400 lb per square inch absolute reactor-inlet pressure, used in the marine installation described here, has been shown to be reasonably conservative in the studies of the transient behaviour of the reactor, and has been dictated largely by economic considerations.

The main parameters are listed in Table I and the layout is shown in Fig. 20.

Core and Pressure Vessel

The fuel elements are sleeved in graphite, which facilitates fuel handling. The sleeves are keyed longitudinally into each other and finally into the reflector at the hot end of the reactor.

The fifty-four fuel channels and seven control-rod channels are on a triangular lattice pitch of 11in (279mm). The central control-rod channel contains also the start-up source. The core and reflector, built of hexagonal blocks, form a hexagonal structure designed to accommodate Wigner shrinkage,[2] and rest in a vee support in the pressure vessel. Eight restraint mechanisms apply a small positive loading to the remaining four flats of the hexagon, and these mechanisms are locked hydraulically to restrain the core structure in position under shock conditions. An interesting feature is that each mechanism can be withdrawn individually from the pressure vessel, without disturbing the stability of the system.

The cylindrical pressure vessel of 3½in (89mm) wall thickness has dished ends, has an internal diameter of 15ft (4570mm), and weighs 135 tons (137 tonnes). It is mounted on radial keys on the inner steel shield ring to allow for differential radial and axial thermal expansion. The standpipes at either end of the reactor are housed in stepped tubes; removable plugs in the ends of the standpipes form the primary-circuit gas seals, and plugs in the ends of the tubes form the secondary containment.

Shield

For maximum economy, the shield structure is made to perform four main functions:

(1) The steel is used for gamma shielding.

(2) It acts as a receptacle for the water neutron shield.

(3) It forms the main support structure for the entire installation.

(4) The flat, sloping slides, the bottom, and the end plates, form part of the containment.

The construction of the shield is cellular, the voids being filled with demineralised water which is circulated through an external cooling circuit. The inner cylindrical shell supports the pressure vessel; on the outside of this shell a boron-steel layer absorbs back-scattered neutrons thermalised in the subsequent water layers. The three shells of the main shield are spaced apart by castellated formers at a longitudinal pitch of 30in (9144mm); this forms an extremely rigid and strong structure. The outer shell supports the steam-raising units and the enclosing containment dome is attached to this shell. As can be seen from Fig. 20, the cylindrical cellular structure of the main shield is closed at either end by a number of flat discs which are penetrated by the tubes housing the standpipes.

Primary Circuit

The coolant enters the reactor channels through ports in the standpipes at the cold end. At the reactor-outlet end it passes into the hot manifold which is sealed to the end support plate which, in turn, is sealed on to

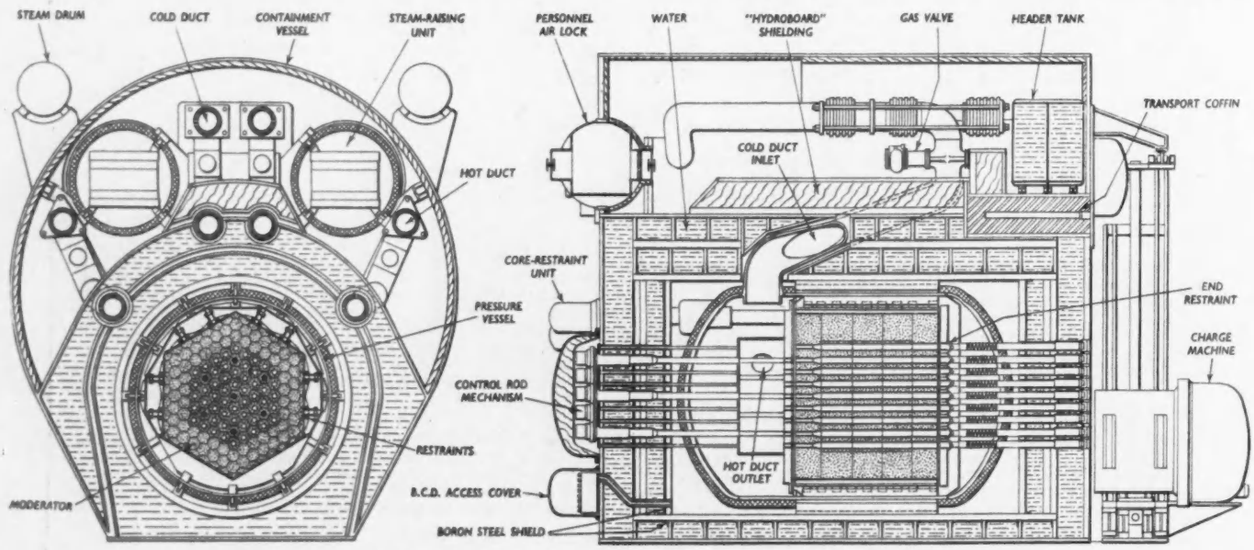


Fig. 20—Transverse and longitudinal cross sections through the centre of the marine reactor installation

TABLE I.—*Some Leading Parameters for the 20,000 s.h.p. Marine Reactor Installation*

Number of reactors	1
Reactor heat output	55MW
Fuel and canning :	
Fuel	Uranium dioxide
Enrichment	3 per cent
Total weight of uranium dioxide	1·39 tons (1·41 tonnes)
Can material	18/8 stainless steel
Thickness	0·010in (0·25mm)
Maximum design surface temperature, including hot spots	1370 deg. Fah. (743 deg. Cent.)
Number of fuel elements per reactor	162
Temperature coefficient of reactivity, irradiated, at operating temperature :	
Fuel	$-2{\cdot}4\times10^{-5}$/deg. Cent.
Moderator	$+4{\cdot}9\times10^{-5}$/deg. Cent.
Moderator and reflector :	
Material	Graphite, Grade A
Nominal core diameter	7ft (2130mm)
Core length	7ft (2130mm)
Reflector thickness	2ft (609mm)
Machined weight of graphite	44 tons (45 tonnes)
Channel diameter	5·06in (129mm)
Channel pitch, triangular	11in (279mm)
Pressure vessel :	
Shape	Cylindrical with dished ends
Diameter, outside	15ft 7in (4750mm)
Thickness	3½in (89mm)
Working pressure, differential	385 lb/in² (27·1kg/cm²)
Maximum temperature	500 deg. Fah. (260 deg. Cent.)
Control and shut-down rods :	
Number of control rods (cylindrical)	7
Material (graded)	Boron steel, clad in stainless steel
Drive	A.C. motor, geared
Insertion rate :	
Fast	1·8ft/min. (549mm/min.)
Slow	0·675in/min. (17mm/min.)
Reactivity invested	19 per cent
Number of shut-down rods (semi-flexible)	7
Material	Boron steel, clad in stainless steel
Drive	Pneumatic
Insertion rate	Complete in less than 1 second
Shielding materials	2 per cent boron steel, steel, water, "Hydroboard"
Coolant circuit :	
Gas	CO_2
Maximum working pressure	400 lb/in², abs. (28·1kg/cm²)
Total maximum flow	371 lb/s (168kg/s)
Reactor inlet temperature	500 deg. Fah. (260 deg. Cent.)
Reactor outlet temperature	1020 deg. Fah. (549 deg. Cent.)
Circuit pressure drop	50 lb/in² (3·5kg/cm²)
Steam-raising units :	
Number	2
Maximum evaporation (each s.r.u.)	80,555 lb/hour (36,540kg/hour)
Temperature at superheater outlet	850 deg. Fah. (454 deg. Cent.)
Pressure at superheater outlet	600 lb/in², gauge (42·2kg/cm²)
Feed temperature	240 deg. Fah. (116 deg. Cent.)
Pressure shell :	
Inside diameter	7ft 6in (2286mm)
Thickness	1¾in (44mm)
Length, including domed head	34ft ¾in (10,382mm)
Containment :	
Internal radius of containment dome	17ft 6in (5334mm)
Wall thickness	1¼in (31·7mm)
Overall length over access covers	44ft (13,410mm)
Overall height	37ft (11,278mm)
Overall width	35ft (10,668mm)
Summary of weights :	
Pressure vessel	135 tons (137 tonnes)
Pressure vessel contents, including standpipes, control rods, reactor, fuel, restraints, &c.)	171 tons (174 tonnes)
Primary circuit and CO_2 ancillary equipment	30 tons (30 tonnes)
Steam-raising units (total) and ancillaries	115 tons (117 tonnes)
Turbines and circulators	14 tons (14 tonnes)
Charge/discharge machine and structure	80 tons (81 tonnes)
Biological shield and header tank	1234 tons (1254 tonnes)
Containment and "Hydroboard" shielding	161 tons (164 tonnes)
Spent fuel storage coffin	40 tons (41 tonnes)
Total	1980 tons (2012 tonnes)

the moderator blocks. Two internally insulated hot ducts pass from the manifold, through the pressure vessel and shield, and through the steam-raising unit shells to the rectangular ducts which house the tube banks. After flowing over these banks, the coolant returns via the annulus between duct and shell to the circulators. The return ducts from the circulators to the reactor pressure vessel join in a Y-layout to a single duct entering the pressure vessel at the same end as the hot ducts. The cold gas returns round the outside of the reflector to the inlet-end standpipe ports. With this arrangement, both steam-raising unit and reactor pressure vessels, and their internal support and restraint systems, are maintained near the coolant gas reactor-inlet temperature.

Each duct contains an isolating valve so that the reactor can be operated with one of the steam-raising units out of commission and isolated from the system. The return bends in the ducting necessitated by shielding requirements, and the arrangement of the bellows units compensating for differential thermal expansion, may be deduced from Fig. 20.

Steam-Raising Units and Coolant Circulators

The steam-raising plant consists of two assisted-circulation water-tube boilers, each being subdivided into economiser, evaporator and superheater units. The design is based on two major considerations :

(*a*) The use of the maximum cross section of shell for gas-flow area.

(*b*) Maximum simplicity in erection, fabrication and replacement or repair of defective tubes.

The banks are enclosed in a rectangular gas-tight casing within the pressure shell. Rollers distributed along its length at three corners support the casing through the shell on the main steam-raising unit support structure. A removable head at the forward end of the steam-raising unit vessel provides sufficient access to permit withdrawal of complete tube banks ; they are removed through an access cover on the end of the containment structure.

Three sets of radial lugs support the steam-raising units and allow radial and axial thermal expansion ; axial location is provided at the circulator turbine support which is mounted in the end structure of the containment. Single-stage centrifugal circulators are directly coupled to the steam turbines. Two seals, placed back to back on either side of the roller bearing supporting the shaft, provide primary circuit and containment sealing. The turbines are thus completely accessible from outside the containment.

Charge/Discharge Installation

On-load charge/discharge facilities are provided. The remotely controlled charge machine is contained in an outer, fully shielded, pressure vessel and mounted on a slide which runs on fixed vertical guides. The provision of a separate standpipe for each channel and the relatively short channel length allow a considerable simplification compared with the designs of the current land-based power station installations using gas-cooled reactors.

The internal charge-machine pressure vessel houses the charge chain, grab and drive, and the storage magazine containing fourteen storage holes. To discharge the channel under load, the seal is first made between the charge-machine containment and the main containment over the appropriate plug. After purging the machine containment with CO_2 and after removal of this plug, a second seal is made on to the standpipe before pressurising the machine pressure vessel to reactor pressure and removing the standpipe plug to gain access to the channel contents.

Channel cooling on discharge is provided normally by the differential pressure across the main circulators through twin concentric flexible hoses to the machine ; an independent emergency supply of coolant CO_2 is provided, and the initial removal of decay heat from the discharged elements takes place in the machine. Normally, these elements are discharged into the transport coffin for removal to shore ; if faulty and removed at sea, they are stored in mortuary channels which can house up to eighteen elements.

Coolant Supply and Auxiliary Circuits

Included in the installation are a number of auxiliary circuits, such as containment and shield coolant systems, filters and driers for the primary coolant circuit, reactor blowdown and evacuation circuits, and an activated-carbon-filter iodine trap for use during blowing down of the containment volume should a reactor fault occur in which activity is released from the fuel elements. An interesting auxiliary is the provision of a carbon-dioxide manufacturing unit on board ship. It is a self-contained plant capable of sustained production of CO_2, with a purity of 99·96 per cent, from the flue gas produced by burning bunker boiler oil. The reactor is thus entirely independent of an external source of supply of coolant.

Fuel Cycle

A number of alternative fuel cycles have been investigated, and that chosen will depend on the operational requirements in any particular case. The choice probably lies between the "once-through" cycle, batch loading, or an equilibrium system.

Fuel burn-ups in excess of 15,000MWd/t appear to be completely practicable for solid uranium-dioxide pellets canned in stainless steel, according to the latest data from the United States ; an economic burn-up limit, taking into account the necessary increase in initial enrichment with increase in burn-up, is probably lower than this. Fuel-element design has to take into account internal pressure in the fuel capsule due to the release of fission-product gases from the fuel, and the low conductivity of irradiated uranium dioxide.

The once-through system is the simplest, and with a fuel rating of about 40MW per tonne would give a charge life of over 300 days. However, provided that the charge/discharge facilities are simple and reliable in operation, as in this design, no economic penalty results from having frequent fuel loadings, and it is of great advantage to use a three- or four-batch fuel cycle. This decreases both the initial enrichment required to achieve a given fuel-element life and the amount of excess reactivity which must be controlled when fresh fuel is inserted into the reactor. The time required to reload one-third of the core in the 20,000 s.h.p. design is just over one day ; for an average burn-up of 12,000MWd/t the period between refuelling would be over 100 days at full power.

Use of an equilibrium fuel cycle gives a further slight reduction in enrichment. It would involve the transport on board ship of at least part of the replacement fuel, and the storage of the discharged fuel elements. Additional mortuary holes could be provided in the reactor shield without difficulty and with little penalty in increased weight, and it has been estimated that the saving in fuel costs for a 20,000 s.h.p. design, using the equilibrium cycle instead of the once-through system, would amount to at least £30,000 per annum.

Additional burn-up advantage can be gained by channel inversion and radial shuffling, both of which can be carried out by the present design of charge machine with the reactor operating. These refinements are not, however, proposed until data is available on the behaviour of the fuel elements at high burn-up.

Control and Instrumentation

The reactor is controlled by the insertion of boron-steel cylinders driven by electric motors ; for the 20,000 s.h.p. design there are seven of these, controlling 18 per cent in reactivity (once-through fuel cycle), including a 4 per cent shutdown margin. The boron content is graded to give a linear

relationship between insertion and reactivity controlled. An independent shutdown system consists of semi-flexible boron-steel rods sheathed in stainless steel and housed inside the normal control-rod cylinders. These are driven into the core pneumatically.

The overall control of the plant involves five separate control groups :

1. Control of reactor outlet gas temperature, by control-rod movement.
2. Manual control of reactor gas flow, by speeder control of the gas-circulator turbines.
3. Steam desuperheater control, depending on steam temperature.
4. Evaporator-drum level control, using two-alarm control from drum level and steam flow.
5. Steam pressure regulation, maintaining constant steam pressure upstream of the regulating valve.

The reactor instrumentation includes shielded thermocouples located in pockets in the reflector at the outlet ends of the channels, stainless-steel-sheathed thermocouples fitted to selected fuel elements to give measurement of can temperature, neutron detectors mounted in tubes parallel to the reactor axis and penetrating into the inner water jacket of the shield, and faulty-element detection equipment which samples the outlet gas from every reactor channel. The neutron source mounted in the centre of the reactor ensures that the reactor power is always within the range of measurement of the instruments.

The normal-running and accident-condition characteristics of the control system have been very carefully examined in extensive digital and analogue computer studies, since this is one of the most important aspects of the reactor design.

The normal operating rates of the control

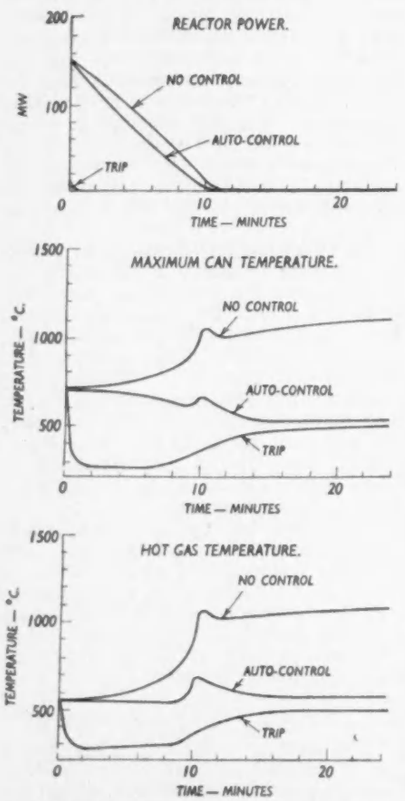


Fig. 21—Typical safety-study results, showing the effect of a steady reduction in gas flow at the rate of 10 per cent per minute (fuel reactivity temperature coefficient based on fuel surface temperature)

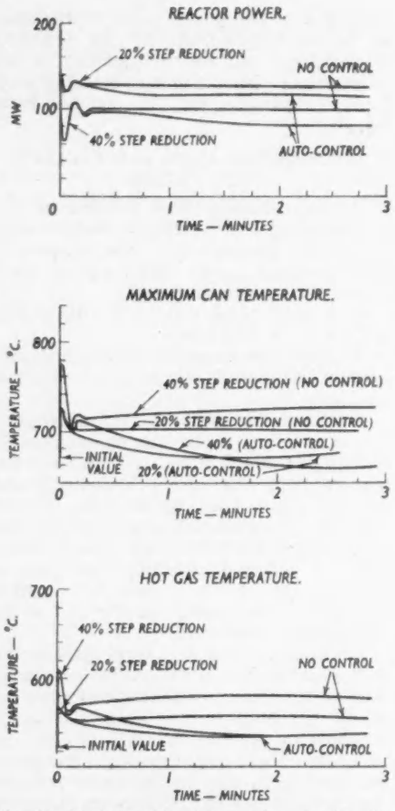


Fig. 22—Typical safety-study results, showing the effects of step reductions in gas flow (fuel reactivity temperature coefficient based on fuel surface temperature)

rods give the following approximate start-up times :

(*a*) *Cold start-up.*—Start to low thermal power, half-hour ; warm structure through, 3 hours ; raise to full power, half-hour. Total, 4 hours.

(*b*) *Hot start-up from trip.*—Trip condition to critical condition, one and a half hours ; critical to full power, half-hour. Total, two hours.

(*c*) *Hot start-up from normal shutdown.*—If it were expected that power would be required soon after shutdown, it would be possible to keep the reactor critical, producing a sub-thermal power, but ready to restart rapidly. Under these conditions the cold-gas temperature would not change widely from its full power value, and no warming through would be necessary.

It is proposed that in order to achieve complete operational flexibility a dump condenser should be included in the steam circuit, and that sufficient xenon over-ride should be provided to avoid any problems arising in starting up the reactor a short time after shutdown. Automatic control of load changes would certainly be satisfactory at rates of the order of 10 per cent of full power per minute.

Hazards

A comprehensive study[3] has been made of the types of faults which affect gas-cooled reactors in general. Analyses of the safety of marine installations have been carried out on the basis outlined in this reference.

A very large number of cases were considered, and some typical results obtained on the analogue computer are shown in Figs. 21, 22 and 23. The maximum temperature to which the can rises under fault conditions depends markedly on the assumptions made, and Fig. 23 shows the same fault conditions as Fig. 22, but with the fuel reactivity temperature coefficient based on the mean fuel temperature, instead of on the fuel surface temperature as in Fig. 22.

From these studies it has been shown that the plant is inherently safer than the land-based power stations currently under construction. This is partly because of the smaller value of the positive moderator temperature coefficient under irradiated conditions, and partly a result of the large temperature margin between operating conditions and melting point (1450 deg. Cent.) of the stainless steel can.

The following chain of circumstances is assumed to constitute the ultimate pressure hazard, and the containment vessel is designed with a large safety factor assuming the fault conditions to occur simultaneously.

(*a*) Evaporator-tube failure in one steam-raising unit, increasing the primary circuit pressure to the safety-valve release pressure, followed by

(*b*) a main-duct fracture, coincident with

(*c*) the fracture of a superheater steam main within the containment vessel.

In determining the ultimate pressure within the containment the addition of decay heat from the reactor core must be taken into account. In the 20,000 s.h.p. design the maximum anticipated pressure under these fault conditions is about 240 lb per square inch (16·9 kilogrammes per square centimetre).

Ingress of air into the core on fracture of a primary coolant duct is prevented by having an atmosphere of carbon dioxide in the containment. There is, therefore, no fire hazard associated with this fault.

Economics

The marine installation that has been described is an advanced version of an

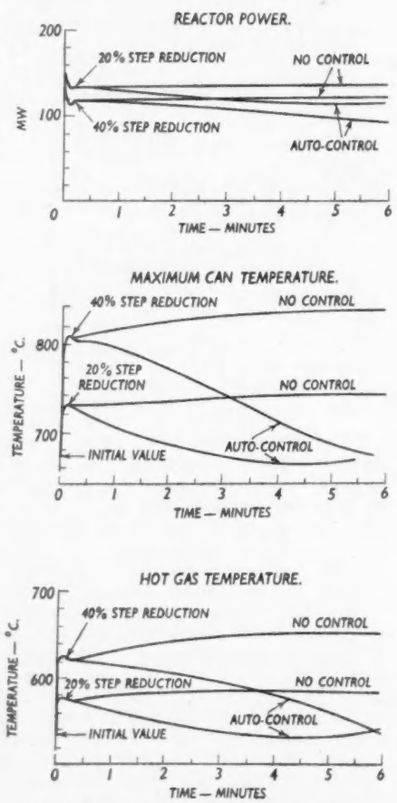


Fig. 23—Typical safety-study results, showing the effects of step reductions in gas flow (fuel reactivity temperature coefficient based on mean fuel temperature)

established system for which a great deal of cost-analysis experience is available in G.E.C., and the possible margin of error in estimating capital costs is thereby greatly reduced. About 62 per cent of the total weight, and 25 per cent of the total cost of the 20,000 s.h.p. installation lies in the biological shield ; unfortunately this is almost independent of output, so that capital costs vary relatively slowly with installation size. The cost of the first marine installation was carefully worked out to form a basis for subsequent modifications, and present estimates of capital cost are : 50,000 s.h.p. installation, £2,500,000 ; 20,000 s.h.p. installation, £2,054,000.

Fuel costs for the two installations do not vary greatly, since the reduction in output from 50,000 s.h.p. to 20,000 s.h.p. has been used to optimise the nuclear conditions rather than to give minimum installation size, so that there is negligible difference in fuel enrichment for a given burn-up in the two cases. For high-load-factor installations, such as a tanker or fast passenger vessel, the larger-size unit is already competitive with conventional power plants, and the lower limit of size for economical operation will certainly be reduced with design improvement and technical innovations, particularly when fuel-element cans of lower neutron-capture cross section become a practical proposition.

It is of interest to examine the economic aspects of the larger installation size in more detail. A suitable use for the 50,000 s.h.p. unit would be to power a tanker with a carrying capacity of, say, 100,000 tons including its own fuel. This vessel would be employed on the route from the Persian Gulf to the United Kingdom via the Cape. With a speed of 20 knots (37km per hour), the tanker would complete five round trips a year. In the case of the conventional tanker, with the normal relationship between Persian Gulf and U.K. fuel-oil prices, the lowest cost per ton of crude oil delivered to the U.K. would be obtained if the ship burned only fuel oil bought in the Gulf, although this would reduce its capacity to deliver crude oil.

The economic comparison between the nuclear and conventional tanker is made on the basis of the cost per ton of crude oil delivered, the conventional tanker being able to deliver only about 84,000 tons per trip, compared with 100,000 tons for the nuclear ship with negligible fuel weight. The conventional fuel cost would be at least 0·25d. per shaft horsepower hour, depending on the current level of fuel-oil prices. The nuclear fuel cost, using enriched uranium containing about 3 per cent ^{235}U, at published prices of the U.S. Atomic Energy Commission, with fuel fabrication and processing carried out in the U.K., and burn-up of about 10,000MWd/t, would be 0·2d. per shaft horsepower hour.

The comparison costs per ton delivered is shown in Table II. Additional insurance for nuclear risks has not been allowed for.

TABLE II.—*Comparison of Costs for Conventional and Nuclear-Powered Large Oil Tankers*

	Conventional £	Nuclear £
Total capital cost including propulsion unit	5,000,000	6,750,000
Annual cost of amortisation, maintenance, and insurance	550,000	742,500
Annual fuel costs (375×10^6 s.h.p.h.)	390,000	312,500
Other operating costs	75,000	100,000
Total annual costs	1,015,600	1,155,000
Tons of crude oil delivered	420,000	500,000
Cost per ton delivered	£2·42	£2·31

A second possible economic use for a nuclear ship-propulsion unit in the near future is in a fast passenger liner. In this case two 75,000 s.h.p units could be installed in a ship to carry, say, 5000 passengers and crew at a speed of about 30 knots (55km per hour). Making one voyage across the Atlantic each week, such a vessel would steam about 150,000 miles (240,000km) or more a year. In this case the fuel cost per shaft horsepower hour of a conventional ship would be high, since fuel oil could not be bought in a cheap market. The economic comparison, shown in Table III, is made at equal speeds ; the much lower fuel cost per shaft horsepower hour of the nuclear ship, and the fact that reactor costs per shaft horsepower hour fall as the required power output is raised, might make a higher speed for the nuclear vessel more economic, in spite of a higher initial cost of the nuclear propulsion unit.

TABLE III.—*Comparison of Costs for Conventional and Nuclear-Powered Large Passenger Liner*

	Conventional £	Nuclear £
Total capital cost, including propulsion unit	25,000,000	28,500,000
Annual cost of amortisation, maintenance, and insurance	2,750,000	3,135,000
Annual fuel costs (750×10^6 s.h.p.h.)	1,406,250	625,000
Other operating costs, including food and stores	3,000,000	3,050,000
Total annual cost	7,156,250	6,810,000

One of the main advantages of reactors with power outputs in the range considered is that the sizes of the components make them suitable for factory production. They would thus be subject to economies of production that cannot be applied to the types of nuclear power reactors at present being built. A working demonstration of the technological and economic feasibility of a reactor of small dimensions would open up possibilities for small land-based nuclear power stations in sufficient quantity to enable capital costs per kilowatt or per horsepower to be considerably reduced.

Conclusions

The marine installation described is based on experience with this system ; marginal uncertainties are thought to be of such a nature that they can be resolved with minor experimental effort. The engineering is conventional and a detailed assembly programme has been worked out with a construction period of two and a half years.

References

[1] *G.E.C. Atomic Energy Rev.*, 2, 2 (September, 1959).

[2] Nightingale, R. E., *et al.*, "Damage Effects to Graphite Irradiated up to 1000 deg. Cent." 1958. *Second United Nations International Conference on the Peaceful Uses of Atomic Energy*, Paper No. A/CONF.15/P/614.

[3] O'Neill, T., "The Specification of Fault Conditions for Gas-Cooled, Graphite-Moderated Reactor Systems." *G.E.C. Atomic Energy Rev.*, 1, 3, (March, 1958), pages 166–173.

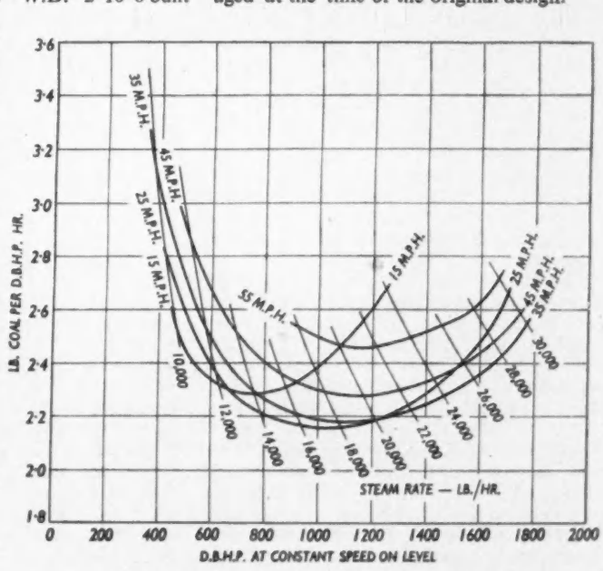
(To be continued)

2-10-0 Standard Freight Locomotive Performance and Efficiency Tests

By O. S. NOCK, B.Sc., M.I.C.E., M.I.Mech.E., M.I.Loco.E.

As the last design of steam locomotive to be built for British Railways the class 9F 2–10–0 has a particular interest, quite apart from the actual details of performance. In practice the class is being used in a far wider variety of service than was envisaged at the time the original design was worked out, and while commenting upon the Test Bulletin *recently published by the British Transport Commission the author refers to work in other spheres that has been done successfully by engines of the class.*

UNTIL the construction of the British Railways class "9F" locomotives a nominal tractive effort of about 35,000 lb at 85 per cent boiler pressure had represented an approximate maximum for British freight tender locomotives. Great Western, L.M.S., and L.N.E.R. designs built over the period 1903 to 1935 all conformed to this general maximum, and even the "W.D." 2–10–0 built during the second world war for wartime duties had a nominal tractive effort of only 34,215 lb at 85 per cent working pressure. At first glance the "B.R.9," with a tractive effort of 39,667 lb., does not appear to be a very great advance, particularly when its boiler is compared with that of the "W.D." 2–10–0. One might also be inclined to question why, if the locomotive were intended for hard slogging freight duties, the coupled wheels were made as large as 5ft diameter, where use of the hitherto standard 4ft 8½in would have given a useful increase of some 2000 lb in tractive effort. But the "B.R.9" was designed at a time when considerable attention was being directed towards the acceleration of freight service, and use of the new locomotives in faster traffic was also in view. As events have turned out the "B.R.9" locomotives have been used in express passenger traffic and have attained speeds far beyond those envisaged at the time of the original design.



Blidworth coal, 12,800 B.Th.U. per pound ; exhaust steam injector.

Fig. 1—Water and coal per drawbar horsepower hour

Purely as freight locomotives a comparison of the leading dimensions with those of the "W.D." 2–10–0 is interesting, particularly as Mr. R. A. Riddles, when Director General of Royal Engineer Equipment during the war, was responsible also for the latter design.

British 2–10–0 Locomotives

Class	"W.D."	"B.R.9"
Cylinders (two):		
Diameter, in	19	20
Stroke, in	28	28
Coupled wheel diameter	4ft 8½in	5ft 0in
Heating surfaces:		
Tubes, sq. ft	1,759	1,836
Firebox, sq. ft	192	179
Total:		
Evaporation, sq. ft	1,951	2,015
Superheater, sq. ft	423	535
Grate area, sq. ft	40	40·2
Boiler pressure, lb/sq. in	225	250
Nominal tractive effort at 85 per cent boiler pressure, lb	34,215	39,667
Total weight of engine in working order, tons	78·3	86·7
Adhesion weight, tons	67·2	77·5
Adhesion factor	4·4	4·38

The cylinder design, and valve events of the "B.R.9" are exactly the same as those of the "Britannia" class 4–6–2, as follows:

Piston swept volume, cu. in	8,796
Cylinder clearance volume as percentage of piston swept volume	10·3
Steam chest volume as percentage of piston swept volume	51·8
Piston valve diameter, in	11
Steam lap, in	1 1/16
Lead, in	¼
Exhaust clearance	Nil
Maximum cut-off in full fore gear, per cent	78

The cross-sectional areas in the passages to steam chest and to exhaust, also the port widths, are the same in both the "B.R.7" 4–6–2 and the "B.R.9" 2–10–0.

This comparison is important in view of the exceptionally free running capacity of the "B.R.9."

Nature of the Tests

There are four varieties of the "B.R.9" locomotive working on British Railways, though at least two of these can at present be regarded as no more than experimental:

(*a*) Standard engine, single orifice blastpipe;

(*b*) Standard engine, twin-orifice blastpipe;

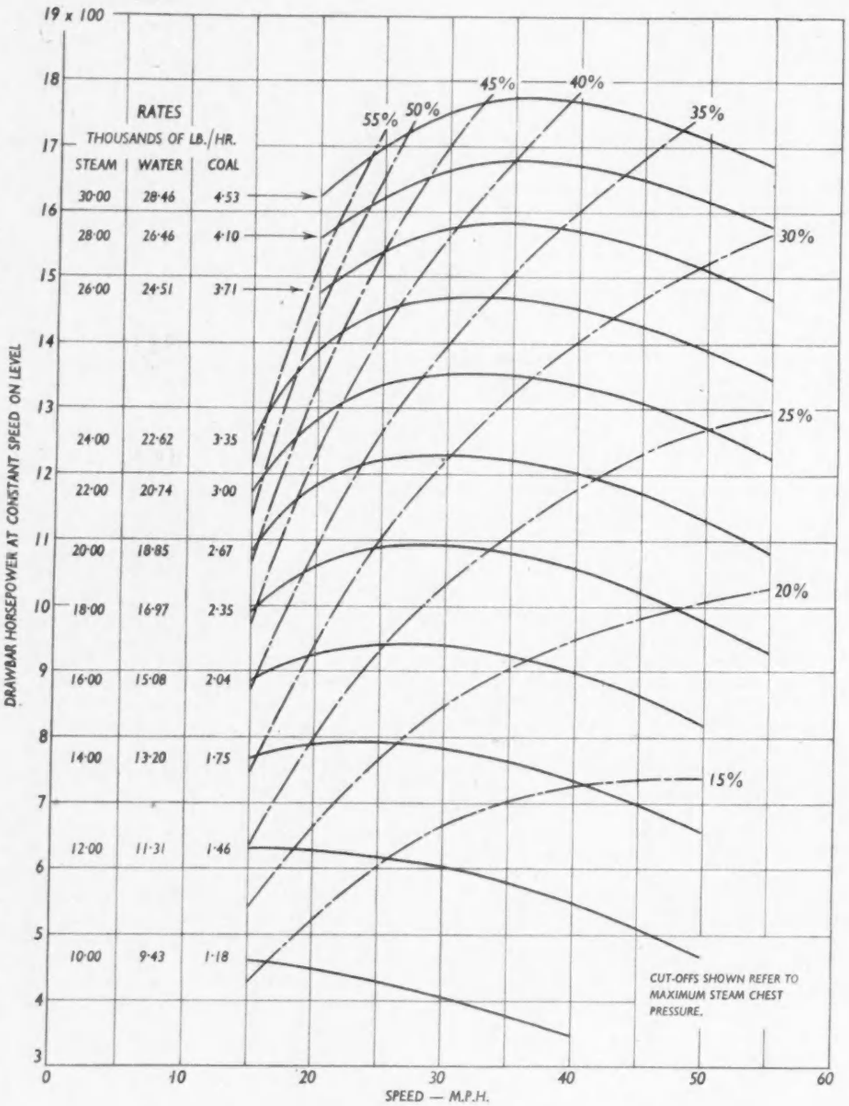
(*c*) Locomotives fitted with Franco-Crosti boiler;

(*d*) One locomotive fitted with Giesl oblong ejector.

The tests covered recently in the bulletin published relate to a standard engine of the original design, except that a small alteration was made to the draughting. Early in the first series of tests it was found necessary to improve the draught in order to reach a rate of steaming commensurate with the dimensions and power classification of the locomotive. There was then no question of any considerable alteration, such as the double chimney and blast pipe fitted to some of the class in 1958, and a simple reduction of blast pipe cap diameter by ¼in to 5¼in sufficed without alteration of the chimney.

The boiler and cylinder performances were first established by tests on the stationary plant at Rugby. These tests were followed by some runs on the line using the mobile testing plant and the London Midland No. 3 dynamometer car. These road trials were carried out between Carlisle and Hurlford, over the former Glasgow and South Western line, and between Carlisle and Skipton, over the now familiar test route over Aisgill summit. These tests were conducted in a number of steps of constant speed for each test, with the Swindon steam flow meter as a guide to the constancy of the steam rate throughout. A few tests were also carried out at variable speeds on the controlled road system of testing with trains of passenger stock, and also with trains of "fitted" 16-ton mineral wagons. Two "B.R.9" locomotives have been fully tested, both at Rugby and on the line, and a third underwent a limited series of tests on the stationary plant. The data presented in the bulletin are considered to be typical of the class as a whole.

On the stationary plant tests were conducted at constant rates of combustion and of evaporation and at constant speed. The coal and water rates were established by the summation of increments method, with the assistance of the Swindon steam flow meter. The range covered by the tests was from 15 to 55 m.p.h., from 15 to 60 per cent cut-off and from 11,500 lb to 29,000 lb per hour of feed water. The great majority of the tests were carried out with the regulator fully open. The tests both on the stationary plant and on the line covered the whole range of power output which the locomotives were capable of sustaining continuously. The tests on the stationary plant were of varying duration, generally for periods of 60 min to 150 min, according to the rate of steaming, after an adequate period of running in the conditions for each test to ensure that stability had been attained. On the line the tests had a duration of from 70 min to 120 min after an initial warming-up period. For tests at rates of firing appreciably above 3000 lb per hour two firemen were used to avoid undue fatigue. These rates of working are greater than anything normally required for train working by engines of this power classification except for periods of very limited duration.

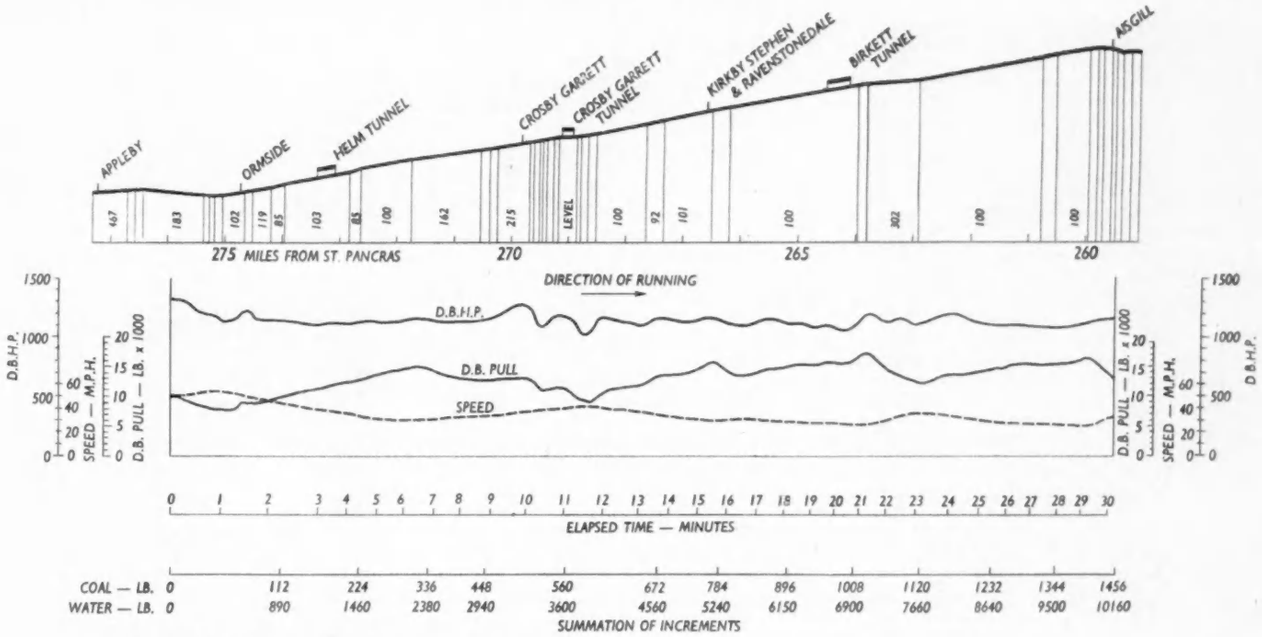


Blidworth coal, 12,800 B.Th.U. per pound; exhaust steam injector.

Fig. 2—Drawbar horsepower characteristics

Test Results

The evaporation recorded with the "B.R.9" makes an interesting comparison with that of the "W.D." 2–10–0 having regard to the similarity of the boilers. The only appreciable difference lies in the blastpipe orifice, which is 5¼in diameter on the "B.R.9" and 4⅞in on the "W.D." With Blidworth coal, having



Blidworth coal, 12,000 B.Th.U. per pound as fired ; exhaust steam injector.
Load 641 tons 10 cwt ; No. 3 dynamometer car + passenger brake van + 20-ton brake van + twenty-five 16-ton fitted mineral wagons + 20-ton brake van.
Water rate 20,050 lb per hour (feed from tender) ; coal rate 2915 lb per hour (inclusive of requirements of auxiliaries).

Fig. 3—Dynamometer car test No. 277, October 22, 1954

a calorific value of 12,800 B.Th.U. per pound, the results were :

Coal fired, lb per hour	Feed water, lb/hour	
	"W.D."	"B.R.9"
1,000	8,000	8,000
2,000	15,000	14,900
3,000	20,900	21,000
4,000	25,600	26,000
4,360	27,000*	—
4,655	—	29,000†

* Front end limit of "W.D." engine. † Front end limit of "B.R.9" engine.

There is, thus, practically no difference between the two designs until the ultimate is reached, when, as might be expected, the locomotive with the larger blastpipe orifice can obtain a higher maximum.

When it comes to comparison of indicated horsepower characteristics the "B.R.9" as might be expected, shows up to great advantage. The "W.D." 2–10–0 was not tested at much above 40 m.p.h., and at that speed the two types show the following results :

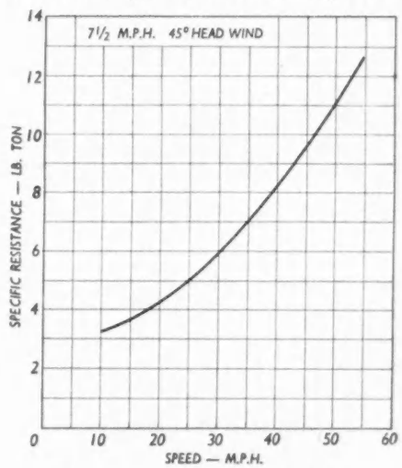
Coal fired, lb per hour	Indicated horsepower at 40 m.p.h.	
	"W.D."	"B.R.9"
1,500	740	760
2,000	980	1,110
3,000	1,340	1,560
4,000	1,550	1,890

Drawbar Horsepower Characteristics

The drawbar horsepower characteristics are shown in the accompanying diagram, Fig. 2, and in comparison with the values of indicated horsepower reveal a remarkably free-running engine. For example, at a speed of 50 m.p.h., some differences between indicated and drawbar horsepowers were:

Steam rate, lb per hour	I.h.p.	D.b.h.p.	Difference
16,000	1,140	825	315
20,000	1,450	1,135	315
24,000	1,710	1,390	320
28,000	1,950	1,625	325

At 30 m.p.h. the corresponding difference is over the range of 145 h.p. to 155 h.p. As might be expected, the basic coal consumption of the locomotive is low, as shown in Fig. 1, not exceeding 2·7 lb per drawbar horsepower hour at 55 m.p.h. at maximum evaporation.



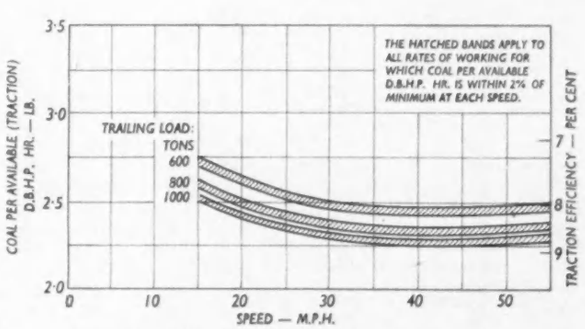
16-ton fitted mineral wagons with class 1 load.

Fig. 4—Specific resistance

Utilisation of "B.R.9" Locomotives

During tests on the line, although no controlled tests were carried out at more than 55 m.p.h., speeds of 60 m.p.h. were attained, and the riding of the locomotive up to that speed was found to be excellent. During the further tests carried out in 1958 with engine No. 92178 fitted with a twin-orifice blast pipe and chimney the present author was privileged to travel in the Swindon dynamometer car on some controlled road tests with a nineteen-coach train of passenger stock, and speeds up to 65 m.p.h. were attained with ease. On certain other runs maximum speeds in excess of 70 m.p.h. were attained. It was clear at various points from the manner of the accelerations on favourable stretches of the line that really high speeds could have been reached, but the brakes were applied to hold the speed down to a maximum of around 60 m.p.h. while keeping a constant rate of steaming. As regards the performance of the locomotive with the twin orifice blast pipe and chimney no details have yet been made public.

Apart from general freight service the "B.R.9" locomotives have been introduced on two duties requiring very heavy and sustained effort at slow speed, namely, the haulage of the ore trains from Tyne Dock to Consett, North Eastern Region, and in similar duty from Alexandra Dock, Newport, up to Ebbw Vale. But the greatest interest is attached to their use in express passenger service. This has taken place not only on excursion and relief trains with which the speed is not unduly high, but they have been used on the heaviest Anglo-Scottish expresses on the East Coast route on duties normally allocated to the Gresley "A3" and "A4" "Pacifics," and have worked these trains between Grantham and London with striking success. On more than one occasion speeds of 90 miles an hour have been attained, on the favourable stretches of line. In this con-

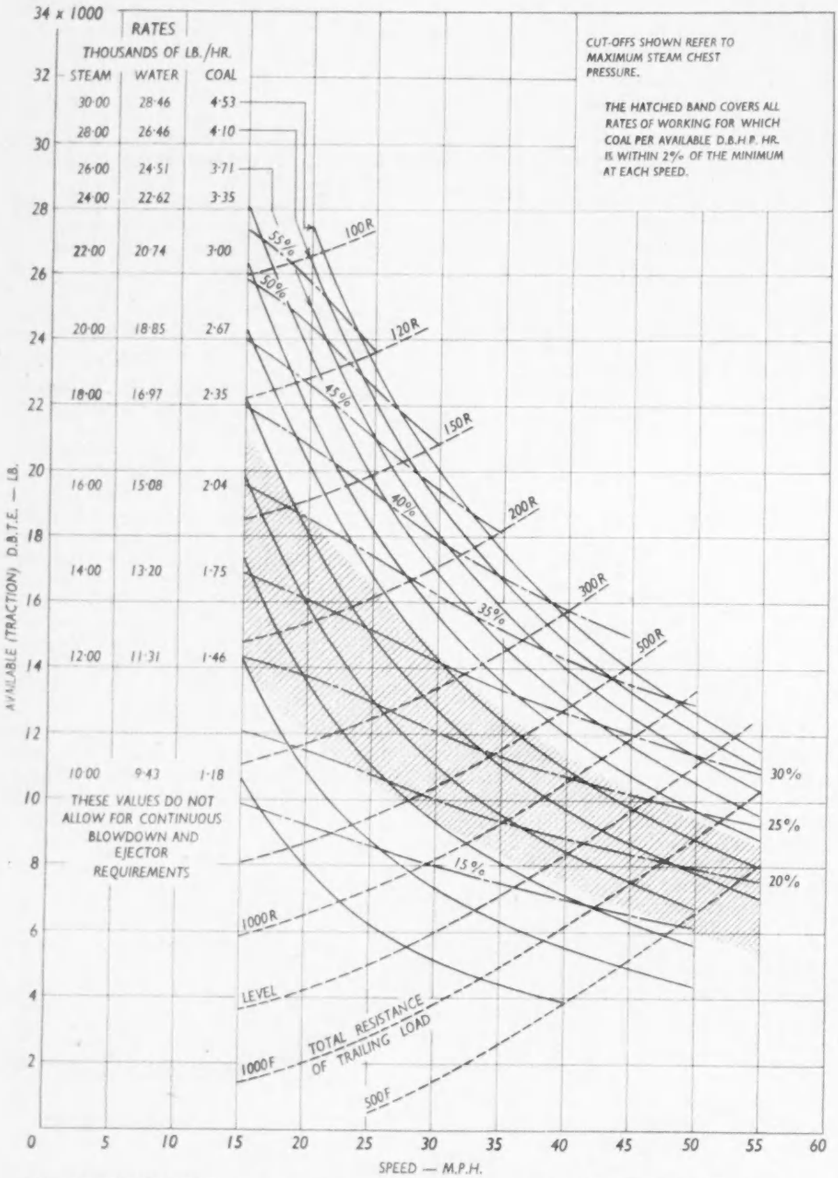

THE HATCHED BANDS APPLY TO ALL RATES OF WORKING FOR WHICH COAL PER AVAILABLE D.B.H.P. HR. IS WITHIN 2% OF MINIMUM AT EACH SPEED.
TRAILING LOAD: TONS 600 800 1000
COAL PER AVAILABLE (TRACTION) D.B.H.P. HR. — LB.
3·5 3·0 2·5 2·0
TRACTION EFFICIENCY — PER CENT 7 8 9
0 10 20 30 40 50
SPEED — M.P.H.

Blidworth coal, 12,800 B.Th.U. per pound ; exhaust steam injector.

Fig. 5—Maximum traction efficiency for various loads

nection it is interesting to refer again to the similarity of the "Britannia" class, or "B.R.7" "Pacific," also a British standard design. Fully authenticated records have been obtained with these latter engines running in express passenger service at speeds up to 102 m.p.h. Having regard to the difference in wheel diameter, at the same piston speed the comparable road speed of the "B.R.9" 2–10–0 would be 83 m.p.h., though at such velocities the air resistance rather than internal resistances within the locomotive would probably be the dominant factor in determining the maximum road speed.

Lastly, there is an example of a variable speed test at constant steam rate between Appleby and Aisgill summit on the Midland Settle and Carlisle line. The test is of interest as showing the performance to be expected with a locomotive fired at the maximum rate that would be expected from a single fireman, namely, a continuous 3000 lb per hour. The actual rate on this test run was 2915 lb per hour, corresponding to a feed water rate of 20,050 lb per hour. The load consisted of dynamometer car, one passenger brake van, two 20-ton goods brake vans, and twenty-five 16-ton fitted mineral wagons, making up a trailing load of 641½ tons. On the long climb from Appleby to Aisgill summit a distance of 16½ miles was covered in exactly 30 min. On the long stretches of ascent inclined at 1 in 100 speed fell only slightly below 30 m.p.h., this representing a drawbar horsepower, uncorrected for gradient, of about 1100 at that speed. The details of this interesting test run are shown in the diagram, Fig. 3. The specific resistance of the wagons used in this test, running against a 7½ m.p.h., 45 deg. head wind, is shown in Fig. 4. As a result of the various tests with trains of freight stock, three diagrams of performance and traction efficiency are included in the bulletin, namely, for 600, 800 and 1000-ton loads. The diagram for 1000-ton load is reproduced herewith in Fig. 6, while the graphs, Fig. 5, show the traction efficiency for various loads. From this final diagram it will be seen that the efficiency of the locomotive is maintained very well over a wide range, and both in its versatility on the road and in its working efficiency the "B.R.9" class can be considered a worthy concluding example of British steam locomotive design.

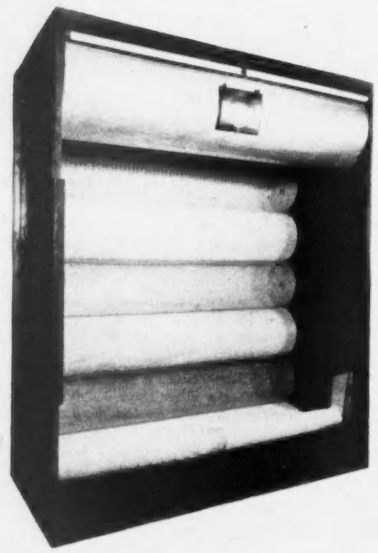

34 x 1000
RATES
THOUSANDS OF LB./HR.
STEAM | WATER | COAL
30·00 | 28·46 | 4·53
28·00 | 26·46 | 4·10
26·00 | 24·51 | 3·71
24·00 | 22·62 | 3·35
22·00 | 20·74 | 3·00
20·00 | 18·85 | 2·67
18·00 | 16·97 | 2·35
16·00 | 15·08 | 2·04
14·00 | 13·20 | 1·75
12·00 | 11·31 | 1·46
10·00 | 9·43 | 1·18
THESE VALUES DO NOT ALLOW FOR CONTINUOUS BLOWDOWN AND EJECTOR REQUIREMENTS
CUT-OFFS SHOWN REFER TO MAXIMUM STEAM CHEST PRESSURE.
THE HATCHED BAND COVERS ALL RATES OF WORKING FOR WHICH COAL PER AVAILABLE D.B.H.P. HR. IS WITHIN 2% OF THE MINIMUM AT EACH SPEED.
55%
50%
45%
40%
35%
30%
25%
20%
15%
100R
120R
150R
200R
300R
500R
1000R
LEVEL
1000F
500F
TOTAL RESISTANCE OF TRAILING LOAD
AVAILABLE (TRACTION) D.B.T.E. — LB.
SPEED — M.P.H.
0 5 10 15 20 25 30 35 40 45 50 55 60
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32

Blidworth coal, 12,800 B.Th.U. per pound; exhaust steam injector; 1000-ton train of loaded 16-ton mineral wagons.

Fig. 6—Performance and traction efficiency

Automatic Air Filters *

WE illustrate a fabric air filter now being made in a number of sizes and capacities by the Ozonair Engineering Company, Ltd., The Esplanade, Rochester, Kent. These filters, as can be seen, have a rigid sheet steel casing and in them the fabric is carried in and out around a series of mesh drums down the full length of the assembly. This method of fabric support gives a large filtering area and its conformation has led to the name of "S" mat being given to the filter. The smallest of these filters made by the firm is 1ft 6in wide by 1ft 9in high, and it has a capacity of 1000 c.f.m. at 0·1in w.g. The largest size is 6ft wide and 15ft high and has a capacity of 63,300 c.f.m. at 0·3in w.g. By using the filters in grouped assemblies any required plant capacity can be provided for.



Air filter with the filtering fabric carried around open-mesh drums

The roll of clean filter fabric is mounted on a shaft at the top of the casing and is drawn down as required on to a shaft at the base of the casing driven by a ¼ h.p. motor at a speed of 2 r.p.m. The mesh drums rotate freely on bearings as the fabric is drawn down, and their design is such that a positive seal is provided down the sides of the fabric. A special fabric medium which is used enables each square foot to be loaded with 70 grammes of dust at 0·5in w.g.

In addition to a simple means of hand-operation, three alternative means of fabric movement control are available with these filters. The winding motor can be actuated by a time switch at preset intervals; it can be switched on and off by a pressure-sensitive control; or it can be switched on and off by a push-button. When hand means of operation are provided, a manometer is fitted to the equipment to show the pressure drop across the filtering medium so that an indication is given when the time has come to roll a clean area of fabric into the operative position.

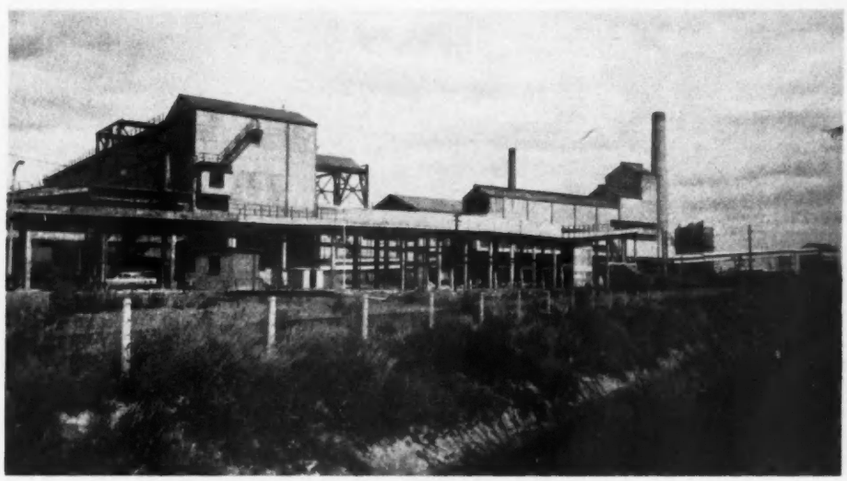
LARGE SINGLE ROLL CRUSHER.—The Fraser and Chalmers Engineering Works of The General Electric Company, Ltd., has recently supplied a single roll crusher, 60in wide by 30in diameter roll, to Atlantic Gypsum, Ltd., Corner Brook, Newfoundland, for the reduction of gypsum rock. The machine, made under licence from Pennsylvania Crusher Company, is the largest of the new "Hercules" medium-duty range. It is capable of breaking 36in lumps of gypsum rock down to 5in size or under at the rate of 400 tons per hour. The toothed crushing roll is driven at 40 r.p.m. by a 250 h.p. G.E.C. slip-ring motor, running at 700 r.p.m., through V-belts and gears.

* Enter No. 3861 on Reply Card.

Ore Preparation Plant

The expansion programme of the Stanton Ironworks Company, Ltd., includes an ore preparation plant which has been completed recently at the company's Ilkeston works in Derbyshire. The construction work has occupied about two and a half years, the total expenditure being nearly £4,000,000.

THE ironmaking practice of the Stanton Ironworks Company, Ltd., Nottingham, has been built up on the use of home ores. With the passing of the years it has become essential to dig more deeply for suitable ore in the Midlands area and it has become necessary to take some supplies from further afield in South Lincolnshire and Oxfordshire. These ores are rather more difficult to smelt and, in order to obtain the best results in the blast-furnaces, the ore must be completely prepared. A well-prepared burden for the furnaces results in more efficient iron production.

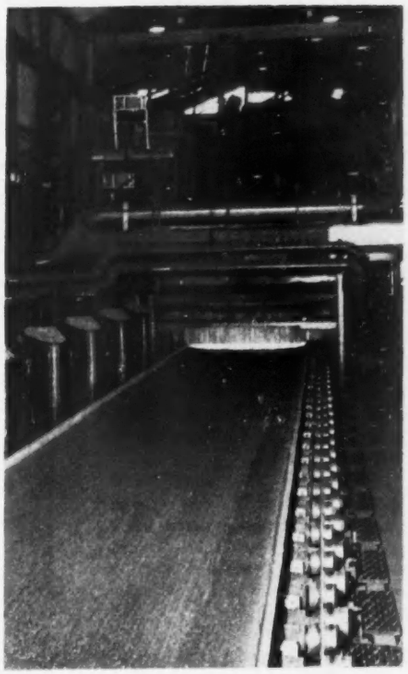


Crusher house, sinter plant and distribution bunkers

The new ore preparation plant at the Ilkeston works, which was officially opened on October 1 by Mr. F. le Neve Foster, occupies a site of approximately 40 acres. It has been designed to process between 25,000 tons and 30,000 tons of ore a week. The ore is transported by rail, new sidings having been laid down to accommodate 503 full wagons on seven roads, and 186 empty wagons on four roads. From these sidings the wagons are fed by gravity to a haul which delivers them to a tippler capable of dealing with thirty wagons an hour. From the tippler hopper, the ores pass through rough screening feeders to a primary crusher which is rated at 800 tons an hour. The crusher rolls are set at 6ft 4½in centres to reduce the lump ore to a size between 6in and 8in; the ore then joins the rough screened material and is conveyed to secondary crushers which reduce it to a maximum size of 3in. Following this secondary crushing, the ore is conveyed to a bedding plant where it is spread horizontally in piles, each containing 6000 tons and is subsequently reclaimed in vertical slices to ensure a uniform mixture of the various constituents. The reclaimed ore passes to the screen house where material of less than ½in is screened out and conveyed to the sinter plant stockyard. Material over ½in size is conveyed via distribution bins to one of the two blast-furnace plants.

Imported ore fines can be delivered on a by-pass conveyor direct to the sinter plant stockyard, which is 600ft long and has a capacity of approximately 50,000 tons of ore. For the greater part of its length, 450ft, the stockyard is an open space, the remaining 150ft being covered in to protect the immediate stock piles, which are adjacent to a battery of eight blending bunkers equipped with ancillary table feeders. The sinter material, consisting of various kinds of ore and coke fines, is discharged in the correct proportions on to a conveyor. The sinter mix is conditioned in a trommel mixer and evenly spread on the continuously moving sinter strand. The mix is ignited under a hood fired by blast-furnace gas, as shown in our second illustration, and, as the strand moves along, combustion is continued by means of air drawn through the bed of material by an extraction fan. The hot sinter is discharged from the end of the machine, through a breaker and a hot screen for removing fines, into a large diameter rotary cooler, the fines being returned to the blending bunkers for incorporation in the sinter mix. Cooled sinter is delivered by conveyor to the distribution bunkers for discharge to the blast-furnace bins. Dust extraction equipment has been installed at every critical point on the sinter plant to prevent any emission of dust.

The whole of this ore preparation plant is fully instrumented and the various sections are controlled from central points. The plant serves two blast-furnace plants. The first, known as Old Works, is a two furnace plant, the other, known as New Works, consisting of three furnaces. The two plants are entirely separate installations complete with ancillary equipment including pig casting machines. But in addition to the common ore feed, they have a common coke supply from a battery of eighty-five Becker ovens and there is an extensive distribution system for clean blast-furnace gas. The blast-furnace gas, after cleaning to very fine limits, is used for firing the hot-blast stoves and for generating steam required for operating the turbo-blowers and turbo-generators. The remainder is used for under-firing the coke oven battery, thus liberating about 24,000,000 cubic feet of coke oven gas a day for distribution by the East Midlands Gas Board.



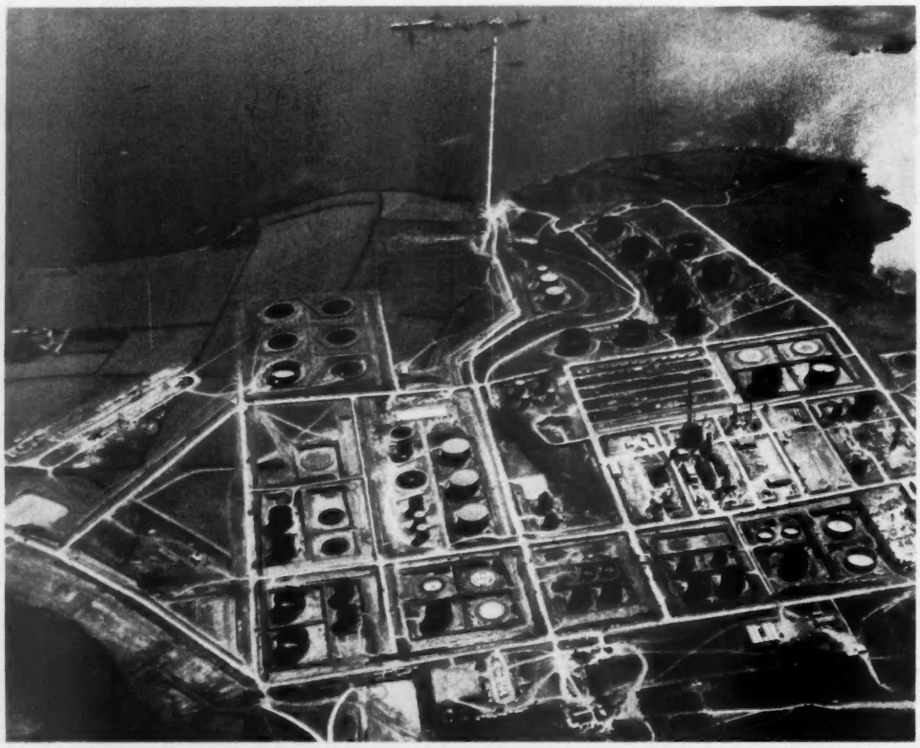
Sinter strand, with (in background) the ignition hood and feed hopper

European Broadcasting Union

MEETINGS of the European Broadcasting Union were held in London between September 21 and October 3. Among the questions considered by the Technical Committee, under the chairmanship of Mr. E. L. E. Pawley, of the B.B.C. Engineering Division, was work in preparation for future international conferences on the allocation of wavelengths to broadcasting stations in Europe, including those in the v.h.f. and u.h.f. bands. The u.h.f. bands (bands IV and V) have not yet been brought into general use in Europe but television stations are already working in them in Germany and Italy.

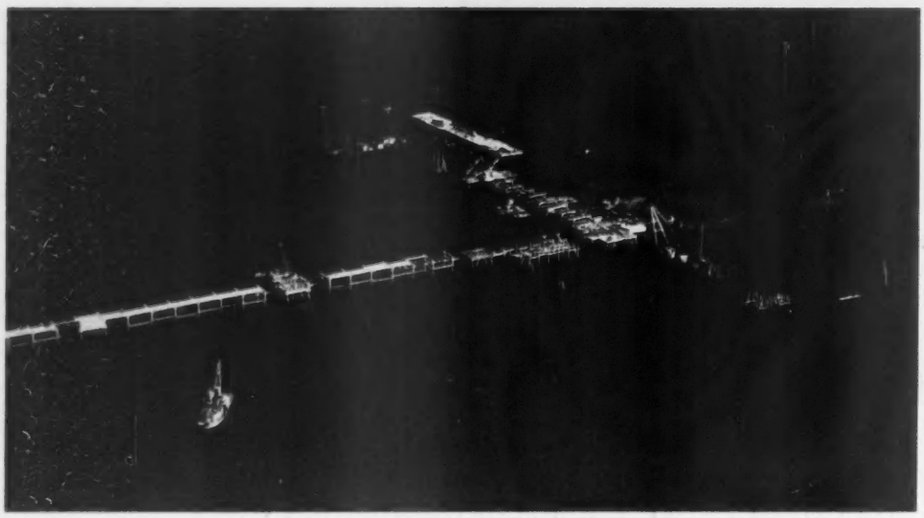
The Eurovision network now includes twelve European countries and is likely to be extended during the next year or two to Finland, Norway and Jugoslavia, possibly to Spain and Portugal, and even to North Africa. It is already technically possible to exchange programmes with some countries in Eastern Europe. Further extension to the U.S.S.R. will be technically possible when the link between Moscow and Warsaw is completed, which has been reported to be likely in 1960. Programme exchanges between European countries are supervised by the E.B.U. Technical Co-ordination Centre in Brussels. The committee also discussed the conversion of television signals from one standard to another, including the conversion to the European standards of programmes received from the U.S.A. on video tapes. During the meeting the recent B.B.C. development in tele-recording of films transmitted by transatlantic cable was studied (see our July 3 issue, page 7) and plans were considered to make use of this system in Europe.

Milford Haven Refinery and Jetty



Constructional work has reached about the half-way stage at the new refinery of the Esso Petroleum Company, Ltd., at Milford Haven, and it is estimated that the refinery will go "on stream" towards the end of next year. At present the company's refinery plant is all at Fawley, where it is considered an optimum size has been reached. The major consideration in the choice of the new site was accessibility for the largest tankers. This has meant a certain disadvantage from the point of view of distributing the refined products, which will be sent, mainly by sea, to centres in the western part of the country.

Initially, the new refinery will handle 4,500,000 tons of Middle East crude per annum. The refined products will be propane, butane, petrols, turbo-jet fuels, autodiesel, gas oil and fuel oils. The complete project will cost about £18,000,000. The actual refining plant is compactly laid out in the centre of the refinery area, as our first illustration clearly shows, and consists principally of a pipestill, having a furnace of about 500 million B.Th.U. per hour output, a hydrofiner, a power former and a copper chloride sweetening plant. There is also a boiler plant with two 130k-lb per hour (at 150 lb per square inch gauge and 450 deg. Fah.) boilers, and, of course, extensive storage for crude oil and refined products.



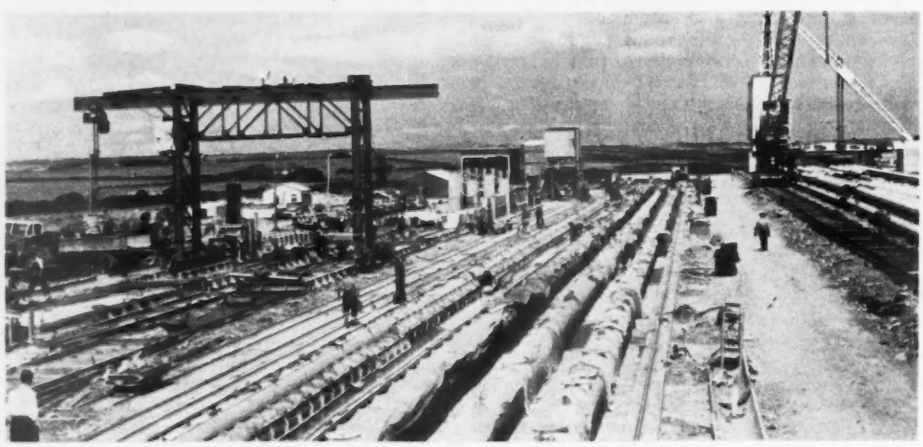
Points of special interest in the refinery include more complete automatic control than has been attempted before, with all the refining processes dominated by a single control room. The pipestill furnace is very large, being matched in size by only one other (at Rotterdam). Furthermore, air cooling is used, thus dispensing with a large cooling water demand. The pipestill alone has fourteen "Air Fin" coolers, operated by 10ft diameter fans.

Landscaping has received special attention and the refinery structures are grouped into a valley largely below the skyline of the headland. Tree-planting will complete this treatment.

The principal contractors for the refinery itself are Foster-Wheeler, Ltd.; the Motherwell Bridge and Engineering Company, Ltd.; William Neill and Son (St. Helens), Ltd.; Whessoe, Ltd.; and George Wimpey and Co., Ltd.

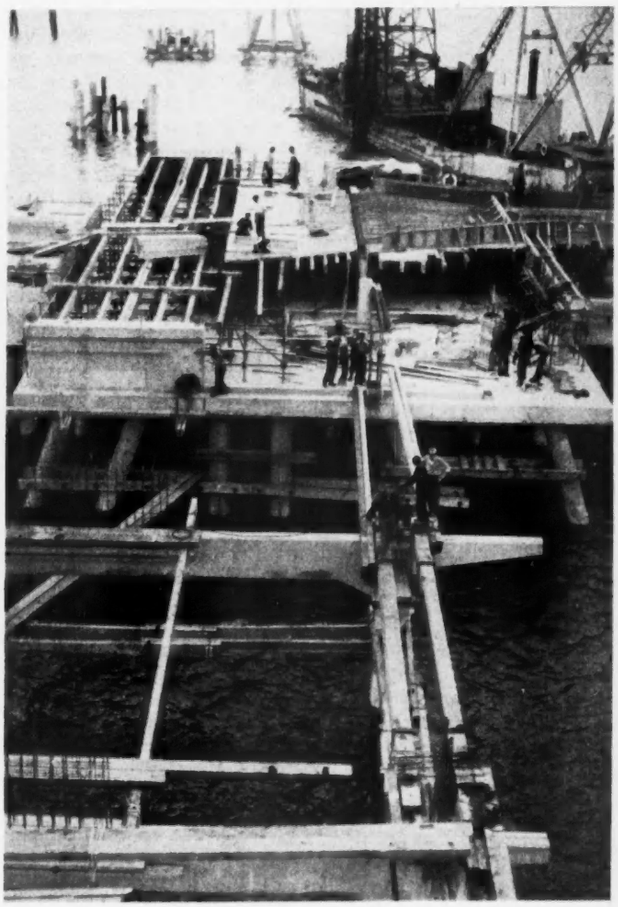
At this stage much interest centres on the jetty, which extends about 3500ft into the Haven, and will be headed by two outside berths, each able to take a tanker of 100,000 tons at all states of the tide, and an inside berth for ships up to 5000 deadweight tons. The tidal range at the site is about 22ft, and a depth of about 54ft will be available at the berths at low water.

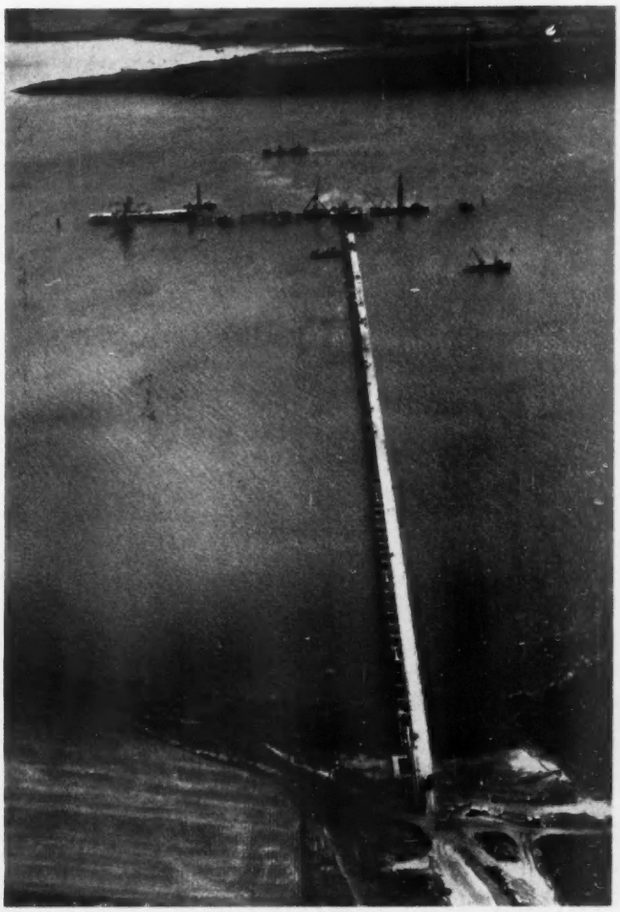
Esso Research and Engineering Co., prepared an outline specification for this jetty, and then asked selected firms for tenders, the tenders incorporating the

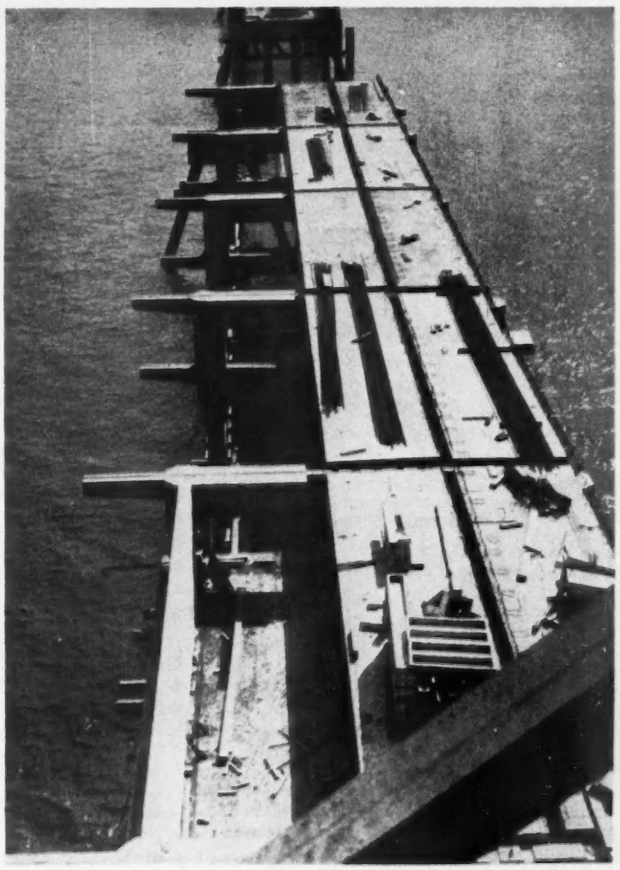


firm's own detail design and method of construction. The successful contractor was John Mowlem and Co., Ltd., and a good idea of the methods which this firm is using can be gained from the various illustrations.

The jetty is carried on prestressed concrete piles, which are hollow cylindrical piles up to about 140ft in length. The piles are either of 27½in or 22in outside diameter, and weigh up to 18 tons. They are generally driven to a bearing stratum of hard mudstone. Construction of the jetty is further characterised by the extensive use of precast concrete, and of floating plant. The two aerial views of the jetty, taken at the same time, give a good general idea of all this. In the approach, raker piles are concentrated at strong-points, where horizontal loads can be taken. The barge "Swale" is shown concreting walls (this is *in situ* work) at strong-point No. 9, and the vessel "Ebury" is preparing to place precast road units. A 135ft pile, for the dolphin "J," is being pitched by the converted L.C.T. "Grosvenor." This vessel is also shown in the LEFT HAND illustration on this page, where the piling for the two dolphins, "H" and "J," is shown completed and construction of the head of the jetty is well shown. The LOWER view gives a good idea of the construction of the approach. Pipes are carried at the lower level, and a road, and to the left, more pipes, at the upper level. The cross trestles are precast, each weighing about 15 tons, there being a separate trestle for the lower and upper level, with a joint between them.







The casting yard can be seen to the left of the refinery, in the first illustration, but it is shown in greater detail in the illustration at the foot of page 388. A pretensioning plant is installed here, and up to five piles can be cast simultaneously on a 500ft length of casting bed. The mix for these piles is a rich one, giving a minimum strength of 7500 lb per square inch at twenty-eight days. The inner surface of each pile is formed by pretensioned wires, which are threaded over expendable concrete formers, and then tensioned sufficiently to maintain the circular shape. They are then wrapped with paper, which forms the interior shutter. When the shutters are to be struck, a "go devil" is drawn through the centre, thus smashing all the formers; the wires are then released and drawn out. A 20-ton derrick at the casting yard handles all the precast elements, which are taken to a constructional jetty—itself a substantial work—where a second 20-ton derrick at the jetty head loads barges.

Other points in the design of the jetty include fender piles consisting of large "Universal" steel beams, driven as piles into the sea bed, and separated from the jetty by spring buffers at the top level. There will also be special bollards, taking a 100-ton load each, which will allow quick release of a tanker's moorings. The critical design loading condition for the jetty is the horizontal thrust caused by wind on an unloaded tanker at one of the berths.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ISAMBARD KINGDOM BRUNEL

SIR,—I give below some comments on two letters published on September 25 about the article "Isambard Kingdom Brunel—a Re-Appraisal" published on September 11.

1. Mr. Dickinson's letter.—Mr. Dickinson is of the opinion that the contractors and shareholders who were ruined by Brunel's unbalanced character, deficiencies in administration and design (Mr. Dickinson's words) found sufficient redress in contemplation of Brunel's admitted courage, energy and personal magnetism. This might apply to Sir Daniel Gooch, who, being a bondholder of the Great Ship Company, "Great Eastern's" second owner, bought her from them for £25,000 and promptly sold her for £50,000. The public, however, was very angry with Brunel, which makes it doubtful whether Brunel's charm, &c., did, in their opinion, redress their losses.

That Telford was a hard employer, as Mr. Dickinson says, does not seem to affect the probability that Brunel appears to have been harder. Why did he personally have to work twenty hours a day doing surveys, but that he could not get sufficient surveyors to work for him ?

The account given by Mr. Dickinson of Scott Russell's activities is most interesting, especially for the light it throws on the I.C.E. Council of the 1860s, but it does not seem to have any bearing on the re-appraisal of Brunel.

Two more points in Mr. Dickinson's letter : "The conflict of evidence" to which the article refers was not in the contemporary public squabbles, but in the statements made in the works of Brunel's admirers, chiefly his son and Beamish. If such "great care," as Mr. Dickinson says, was taken in providing the "best navigational aids" for "Great Eastern," how came it that she ran aground off Northern Ireland because her skipper thought she was off the Isle of Man ? Is Mr. Dickinson accusing the long-dead skipper of gross incompetence ? Surely not !

Lastly, so far from Brunel not "shirking his personal, financial and moral responsibilities" (quoting Mr. Dickinson) a scrutiny of his life and actions leads to the thought that his motto appears to have been "Pull up the plank, Jack, I'm all right." It therefore seems useful to investigate the myths about him as myths lead to imitations of the mythical behaviour, with deplorable results.

2. Mr. Young's letter.—Apologies are due to Mr. Young and all other Bristolians for the statement that the Clifton Bridge was near Bath, when it should have been made clear that it was between Bath and Bristol and nearer the latter town, though what difference this could make to a study of Brunel's work is hard to discover. It should be repeated that the existing Clifton Bridge was built after Brunel's death and not to his design. Telford's design came first in the second competition for this bridge, but Brunel, by the exercise of charm, energy and what-all, managed to make the assessors change their mind and give it to him, who messed about for nearly twenty years, with practically no result, shutting the works down entirely six years before his death.

Mr. Young, in turn, refers to the dangers of standardisation as exemplified by N.A.T.O.: says the Atmospheric Railway would have been all right if it worked : says "Great Western" was successful (agreed—as a sailing ship with auxiliary steam) : says "Great Eastern" was scrapped after thirty years (right) during which she laid some cables successfully, became a "Show Boat" on the Mersey and ruined at least two successive sets of owners. These statements do not seem to affect the validity of the account of Brunel's activities, given in the article of September 11.

If Mr. Young has noticed the quotation in THE ENGINEER of September 25, 1959, from THE ENGINEER of September 23, 1859, he will see that Brunel's contemporaries were not filled with such glowing admiration for Brunel and his works as Mr. Young shows in his letter.

F. NEWHOUSE

8, Montpelier Row,
Twickenham,
September 29, 1959.

DEMISE OF THE "POPULAR"

SIR,—I have read with interest and pleasure your leader, "Demise of the 'Popular,'" in your September 25 issue. Your points with regard to the braking system, and ease of repair to wings are well made, hydraulic failures are not uncommon on modern cars as are scratched and dented wings. Your opinion of the engine is endorsed and would suggest as its finest achievement, the longevity of crankshaft and bearings. Doubtless this is due to a generous factor of safety and large oilways.

With regard to its demise, I would lay the blame more on the technical staff than the stylists. The addition of a few extras, spot-lamp, wheel discs and window louvres, make the "Popular" still an attractive and functional motor-car. Recent changes have not been improvements, but have served to cheapen the price. The two most frequent faults, namely, jumping out of second gear and excessive wear in steering nut and track rod ends are still there as they were in 1933. It is strange how weaknesses of many cars of the 'thirties are with us to-day. Incidentally a 1938 Ford 8 or 1949–53 "Anglia" is a better "driver" than the present "Popular," why this should be I do not know, but it is so.

The "Poppy" will be missed, however its successor has many of its proved qualities.

JAMES WATSON

Southampton,
October 3, 1959.

MEANING OF "WATERSHED"

SIR,—I am rather surprised by the sense in which the term "watershed" is used in your leading article of to-day's date on "Water Shortage in Some Areas." One is used to take "watershed" to mean the line of division between the river basins to which you intend to refer, and not the basins themselves.

A. S. WINDER

Boxmoor, Herts,
October 2, 1959.

[The Shorter Oxford English Dictionary gives as one of the meanings of the word, "The whole gathering ground of a river system." It dates from 1874. But the Dictionary also qualifies the meaning by adding in italics the word "loosely." In the circumstances one must appeal to practice. Our impression is that British civil engineers do use the term in the sense of "the whole gathering ground of a river system." Perhaps we are wrong. Webster's New International Dictionary, 2nd Edition, fully supports our use of the word.—ED., THE E.]

SPIRALLY-WELDED TUBULAR PILES

SIR,—Your issue of September 25 contains a letter from Mr. D. N. Jones in which he refers to his inspection of some spiral-welded pipes and to the serious defects which became apparent when they were driven to form the pile foundations of a bridge.

I have reason to believe that these pipes were welded only on the outside of the helical seam. That being so, they differ essentially from those which have been manufactured in this country since the beginning of this year and which are welded not only on the outside but also on the inside of the seam. It is no exaggeration to say that in these pipes the strength of the welded joint is at least equal to that of the parent metal.

On the basis of his experience with pipes welded only on the outside, Mr. Jones recommends that all spiral-welded pipes should be hydraulically tested before acceptance even if they are to be used only for pile foundations and not for pipelines under pressure. I submit that this is an unnecessary expense, at any rate for pile foundations, in the case of pipes that are welded inside and out as now produced in this country. This is confirmed by the fact that a very large number of such piles have now been used on some twenty-five or thirty contracts under a variety of conditions. Some of them were base-driven with an internal drop hammer and some top-driven in the conventional manner. They were, of course, subjected to routine inspection by the manufacturers during production, but none was tested hydraulically and no failures in the welded seams have appeared, notwithstanding very hard driving on some of the sites.

S. PACKSHAW

The British Steel Piling
Company, Ltd.,
10, Haymarket, London, S.W.1,
October 2, 1959.

HYDRAULIC PRESSURE EXPANSION TECHNIQUE

SIR,—I was surprised to note in the September 25 issue of THE ENGINEER a reference to the Timken hydraulic pressure

expansion technique used in the propeller assembly of the new Vosper patrol boats and described on page 306. The technique to which you refer was originally devised by the Swedish SKF Company about fourteen years ago in connection with the design of a rigid shaft coupling for marine propeller shafts. It was the subject of an SKF patent which lapsed only recently, hence its more widespread use at the present time.

A paper on this subject was read by an SKF engineer at the Fifth International Mechanical Engineering Congress, "Some Practical Experience of the Oil-Injection Method for Assembling and Dismantling Pressure Joints," by Civ. Ing. Erland Bratt.

P. MILNE

Newcastle upon Tyne,
October 2, 1959.

Book Reviews

Practical Ironmaking. By G. D. ELLIOT and J. A. BOND. The Publications Department, The United Steel Companies, Ltd., 17, Westbourne Road, Sheffield, 10. Price 40s.

JAMES BOND died shortly before this book went to press and his co-author would have us regard it as some small memorial to tremendous help given over many years. It was written for the men who make their living in iron works, but it will also be valued by any senior student of ferrous metallurgy. Because it was written for them and not for amateurs and juniors, no space has been devoted to the raw materials of ironmaking, and a practical if elementary knowledge of the subject is assumed. It will be most valuable to a keen student, the average operator, the man immediately interested in ironmaking, and so it differs from other books on the same subject.

The blast-furnace places a premium on practical experience and this has been much in mind in the writing of this book. Long and over-comprehensive treatises are seldom read from cover to cover by anyone, and scarcely ever read by the ordinary operator and student. Hence, the authors have deliberately left much out and devoted the greater part of the work to experience at one iron works. There must be diversity in the apparatus used by ironmakers in different parts of the world because there is a wide variety in the raw materials found in nature, from which the iron works may make iron. The reader should therefore bear in mind that the company, which has published this beautifully printed volume, has world-wide interests, some of the finest research laboratories and a highly skilled development staff.

Covering 276 pages in all, the book concludes with a twelve-page chapter of bibliographies, subdivided as follows: the blast-furnace plant and equipment; blast-furnace operation; blast-furnace theory and research; the sintering plant; sintering and ore preparation; sintering—theory and research, and miscellaneous, and textbooks. These headings to the bibliographies serve to indicate the field covered by the book, which has twenty chapters and includes sixty-five figures, seventeen tables and a four-page index.

Even if the authors of this book did not set out to help them in their special employments, many engineers will find it fascinating. Iron is essential for their work, and engineering and constructional problems have had more influence in shaping the blast-furnace than has scientific and metallurgical knowledge of the ironmaking process. Whatever plant and raw materials are used, the operating principles of an iron works are the same the world over.

Dictionary of Guided Missiles and Space Flight. Edited by CAPTAIN GRAYSON MERRILL, U.S.N. (Ret.). D. van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 131s. 6d.

THIS fifth volume in Van Nostrand's series, *Principles of Guided Missile Design*, is intended to be a desk-side companion of the *International Dictionary of Physics and Electronics*. It is stated by Captain Merrill in the Preface that:

"Illustrations and discussions have been supplied where better understanding of important terms will result. . . . Wherever in the definition of a given term other words or expressions are used for which cross reference is available, those words or expressions are printed in bold-face type, so that the reader need only turn to the corresponding entry to find additional information." This description is hardly consistent with entries such as:

"**NATTER. Ba 349.**
"**Ba. Barium.**"

One must, however, acknowledge the justice of a searing reproof to those whom the compilers doubtless think of as "the British" when they specify:

"**INTERCONTINENTAL.** Capable of travelling non-stop between continents."

Elektrische und Elektronische Steuerungen an Werkzeug Maschinen. By PAUL G. VIOLET. Verlag "Technische Rundschau," Halwag, Berne, Nordring, 4. Price Sw.Fr.4.80.

THIS monograph published as No. 10 in the series of special reprints from the *Technische Rundschau*, first appeared in that journal in April, 1958, and deals comprehensively with the electrical control of machine tools, with special reference to the examples shown at the Fifth European Machine Tool Exhibition at Hanover in 1957, without, however, going into details which do not affect principles. The book deals with control by means of end stops and clutches, copying and positioning, and the combination of electro-magnetic and hydraulic means. A large amount of space is devoted to electronic measurements and the transmission of data, speed control and programme control in one, two, and three dimensions.

Etude d'une méthode de mesure des temperatures utilisant la sensibilité thermique des coleurs de fluorescence. By PIERRE THUREAU. Publications Scientifiques et Techniques du Ministère de l'Air, No. 349. Service de Documentation et d'Information Technique de l'Aéronautique, Magasin C.T.O., 2, Avenue de la Porte-d'Issy, Paris (15e). Price Fr.3240

WHILE both the intensity and the spectral distribution of the light from a fluorescent substance are functions of the temperature, only the distribution is suitable for temperature measurements, since the ratio of the intensities of two spectral lines is independent of the excitation. Two substances, anthracene and zinc sulphide, were specially studied by the author, who describes an apparatus for isolating two spectral lines and taking measurements with the help of photo-multiplier cells. The method of evaluating the result is also discussed. Tests were carried out at speeds of 100m per second and 185m per second in order to compare theory and experiment.

Obituary

T. E. GOLDUP

WE regret to record the death on October 6, at the age of 65, of Mr. T. E. Goldup, a director of Mullard, Ltd. Mr. Goldup joined the Mullard company in 1923 after service in the Royal Navy in the 1914–18 war and a subsequent appointment, on demobilisation, as Senior Experimental Officer at the Signal School, Portsmouth. In this capacity he was responsible for transmitting and receiving valve development, and on entering industry in the Mullard valve factory at Balham he was responsible for valve manufacture for the Government and also assisted in the organisation of the valve development laboratories. Mr. Goldup became widely known in industry after his transfer in 1928 to head office to set up a technical service department for advising Mullard customers on valve applications. In 1938 he was appointed a director of Radio Transmission Equipment, Ltd. (now known as Mullard Equipment, Ltd.) and became a director of the Mullard Radio Valve Company, Ltd., in 1940. His appointment to the board of the parent company, Mullard, Ltd., took place in 1951. He had numerous interests in technical education and training, and in 1950 was appointed by the Minister of Supply to the Board of Governors of the Ministry's College of Electronics at Malvern, and was elected Chairman of the Governors in 1952. In the latter year Mr. Goldup was appointed by the Lords Commissioners of the Admiralty as a member of the Naval Education Advisory Committee for the period 1952–59. He received the C.B.E. in 1954, in which year he was made a Fellow of the American Institute of Radio Engineers "for his pioneering achievements in the design and development of thermionic tubes and his contributions to the technical and administrative counsels of the British radio industry." He was president of the Institution of Electrical Engineers in 1957–58, of which institution he had been elected a Graduate in 1922 and became a full Member in 1940. Mr. Goldup was also a Fellow of the Royal Society of Arts, a Member of the Royal Institution, and a Vice-President of the Television Society.

Books Received

Tunnel Engineering. By Rolt Hammond. Heywood and Co., Ltd., Carlton House, Great Queen Street, London, W.C.2. Price 55s.

Mechanical Design and Analysis. By R. R. Slaymaker. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 76s.

Mechanics. Part 2, Statics. Second Edition. By J. L. Meriam. Chapman and Hall, Ltd., 37, Essex Street, London. W.C.2. Price 40s.

Introduction to Stress Analysis. By C. O. Harris. The Macmillan Company, New York, 10, South Audley Street, London, W.1. Price 52s. 6d.

Chemistry for Engineering Students. Second Edition. By R. Hum. Charles Griffin and Co., Ltd., 42, Drury Lane, London, W.C.2. Price 45s.

Materials for Rockets and Missiles. By R. G. Frank and W. F. Zimmerman. The Macmillan Company, New York, 10, South Audley Street, London, W.1. Price 31s. 6d.

The Manufacture of Iron and Steel. Volume 2. Steel Production. Second Edition. By G. R. Bashforth. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 40s.

Reibung und Schierung Fester Körper. By F. P. Bowden and D. Tabor. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3, German Federal Republic. Price DM.41.40.

Progress in Nuclear Energy. Series 1 Physics and Mathematics. Volume 3. Edited by D. J. Hughes, J. E. Sanders and J. Horowitz. Pergamon Press, Ltd., 4 and 5, Fitzroy Square, London, W.1. Price 105s.

Willington "A" Power Station

Willington "A" power station has an output of 400MW from four 100MW sets, all of which are hydrogen cooled (one set having direct cooling of stator and rotor windings). The four boilers are of semi-outdoor construction and are arranged in the form of a square with a central mill aisle and separate turbine rooms on opposite sides of the boiler block. Each boiler is rated at 830,000 lb per hour with stop valve conditions of 1600 lb per square inch gauge and 1060 deg. Fah. Two 200MW sets will be installed in Willington "B" station being built to the north of "A" station to share the coal and cooling water facilities.

WILLINGTON "A" power station which was officially opened on October 2 by the Duke of Devonshire is about halfway between Derby and Burton. It is one of a series of large power stations which take their cooling water from the river Trent and their fuel from the east Midlands coalfield and supply power both to the Midlands and, via the 275kV supergrid system, to the south of England. With its output capacity of 4×100MW Willington "A" is only part of further developments in hand on the same site : a second station, Willington "B" is being built to house two 200MW sets which will double the output capacity.

The main generating plant in Willington "A" consists of four 100MW turbo-generators, each taking steam at 1500 lb per square inch and 1050 deg. Fah. from a semi-outdoor boiler of 830,000 lb-per-hour evaporation. The layout is unorthodox in that the four boilers are arranged in the form of a square with a central pulverising mill aisle and coal bunkers along the main axis of the station. On opposite sides of this boiler block are two separate turbine rooms, each containing two 100MW turbo-generator sets. An interesting innovation is the provision of a demountable 180-ton lifting rig for handling the 100MW sets and the future 200MW sets during erection and dismantling. With this lifting rig to handle the heavier loads the capacity of the overhead travelling cranes required in each turbine room is reduced from about 165 tons to 50 tons, and a substantial saving has been made in the cost of the foundations and superstructure.

There is a plant control room between each pair of boiler turbine units to give fully centralised control of the units in pairs. Switch rooms are sited centrally between each boiler and turbine to shorten the runs of instrument leads and cables to auxiliary plant.

These design concepts have materialised into a compact station layout with an enclosed volume of about 19·5 cubic feet per kilowatt installed in a building using only 13 tons of structural steel per 1000kW of installed plant.

The design, engineering, construction and commissioning of the station were done by Messrs. Ewbank and Partners in collaboration with the supply authority—initially the chief engineer's department of the Central Electricity Authority in London. Later, with the reorganisation of the supply industry, responsibility for construction including the commissioning of No. 4 unit passed from the headquarters of the Central Electricity Generating Board to its Midlands Project Group.

Sir William Halcrow and Partners were responsible to Messrs. Ewbank and Partners for the civil engineering work and Messrs. Farmer and Dark were similarly responsible for the superstructure and architecture.

Work on site began in January, 1954, the first three sets were commissioned by the end of 1958, and the fourth on July 10, 1959.

Station Buildings

The subsoil on the Willington site consists of marl overlaid by a layer of river sands and gravel about 20ft thick. Soil sample tests indicated bearing capacities up to 3 tons per square foot for the gravel and 3½ tons per square foot for the marl. The main items of plant are carried on r.c. rafts and the load varies from about 3700 tons on each of the four turbine house rafts to about 8850 tons on each raft in the mill aisle. The greatest stanchion loads (1000 tons) are in the boiler houses.

Expansion joints separate the independent rafts, which are of cellular construction for the mill and boiler foundations and solid elsewhere. Subsoil consolidation under the foundations is expected to vary from ¼in to about 1in.

Both the turbine halls consist of a reinforced concrete frame with lightweight concrete barrel vault roofs and clad with vertical "Alochromed" aluminium sheeting and glass above brick plinth walls 22ft high.

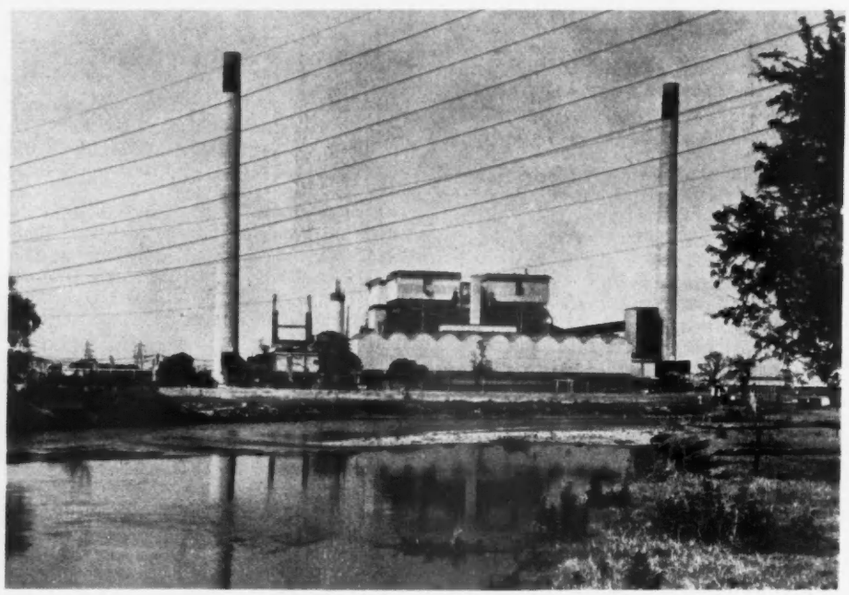
All the boilers and air heaters are exposed above the 67ft and 32ft levels respectively, apart from the aluminium and glass box covers installed over the tops of the boilers. The buildings around the enclosed parts of the boilers and other items of plant are steel framed and, like the turbine houses, are clad in "Alochromed" sheeting and glass above brick plinth walls.

Mainly for reasons of economy reinforced concrete has been used wherever practicable for constructional work ; in parts such as the bunker bay, reinforced concrete has been used integrally with structural steelwork.

Coal Handling

Coal is delivered by rail and the wagons are shunted in the sidings by two 204 h.p. diesel mechanical locomotives, but the wagons are handled through each tippler by inhaul and outhaul beetles. Between the tipplers and the crusher house a magnetic separator probe removes tramp iron from the coal on the conveyor. Deliveries of coal up to 2in are screened and crushed before passing to the transfer hopper, but coal of up to ¾in by-passes the screen and crushers and is delivered direct to the transfer hopper. From this hopper, coal may be delivered to store or to the station bunkers. For the store, coal is conveyed to a boom stacker which forms an initial stock pile ; this pile is then spread over the storage area by bull-dozers which also reclaim coal from the stores into any one of the reclaim hoppers, whence it is conveyed via the coal store junction tower, and, after magnetic separation, to the transfer hopper in the crusher house. Coal in the transfer hopper, delivered either from the tipplers or from the store, is conveyed to the station bunkers.

A special ventilation system serves the underground chambers and conveyor tunnels associated with reclaiming hoppers to prevent the collection of noxious gases.



Willington "A" power station on the river Trent. The chimney and superstructure of Willington "B" can be seen under construction in the background

Boilers

The four boilers are rated at 830,000 lb per hour and are corner-fired pulverised-fuel units working at 1600 lb per square inch and 1060 deg. Fah. at the stop valves.

There are four pulverising mills per boiler and each is rated at 16 tons per hour, but any three mills can serve the needs of the boiler. A three-roller mill is being installed, experimentally, for one of the boilers, to provide practical data for the new mills that will be installed at Thorpe Marsh power station.* Oil-firing equipment is installed

* The Engineer, November 21, 1958, page 804.

for starting-up and load carrying up to 12 per cent of the boilers' needs.

The final steam temperature is held automatically within ±15 deg. Fah. over the operating range 664k-lb to 830k-lb per hour by a combination of tilting burners and spray desuperheaters.

Both mechanical dust collectors and electrostatic precipitators are installed. Retractable lance and gun type blowers are fitted throughout the boiler passes, all soot blowers being electrically operated with automatic sequence control.

Pre-heated air is delivered from duplicate Howden-Ljungstrom regenerative air heaters. Two forced draught fans per boiler deliver air to the pre-heaters, from which a portion is taken to the mills for drying the coal feed and conveying it to the burners. The remainder is delivered around the burner nozzles as secondary air. The induced draught and the forced draught fans, coal feeders, mill classifiers and exhauster are driven by Laurence-Scott " N.S. " variable-speed a.c. commutator motors, speed control being obtained by induction regulators.

The i.d. fan motors are weatherproof machines with closed-air-circuit cooling via air/air heat exchangers.

The ash and dust handling plant is designed to operate on the high velocity sluice system, discharging through basalt-lined sluice ways to a main ash and dust sump situated on the east side of the site.

Feed-water heating is by a six-stage system consisting of three low-pressure heaters (one of which is the deaerator heater) and three high-pressure heaters. The low-pressure heaters are on the suction side of the 700 h.p. booster feed pumps and the high-pressure heaters are between the booster pumps and the 2500 h.p. main feed pumps.

Associated with each turbine is a double-effect bled-steam evaporator delivering 25,000 lb per hour at 100MW turbo-generator output. Before evaporation make-up water is softened and alkalinity neutralised in a sodium-base-exchange softening plant which takes raw water from the South Staffordshire system and has a capacity of 10,000 gallons per day.

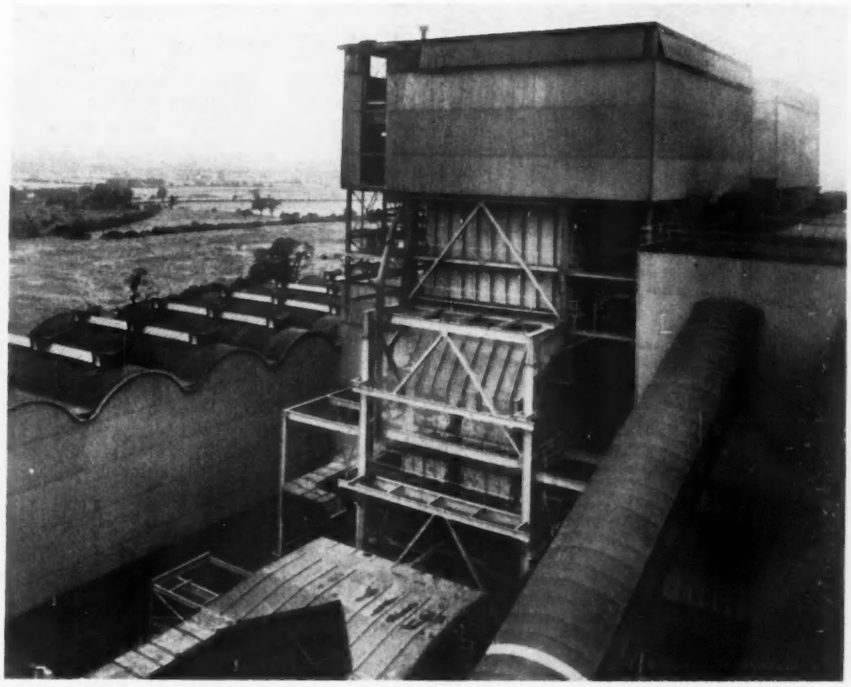
Turbo-Generators

The four turbo-generators are 100MW English Electric sets. Each turbine is an in-line three-cylinder, 3000 r.p.m. impulse reaction machine with a Curtis type first stage and ten impulse stages in the l.p. cylinders and an impulse first stage and five reaction stages in each flow of the double-flow l.p. cylinders. The latter cylinders exhaust to twin two-pass condensers with a total surface area of 76,700 square feet ; condenser vacuum at M.E.C.R., 28·9in Hg. The turbines are equipped with centrifugal main oil pumps driven directly from the nose of the h.p. shaft through gear-type coupling, and they are the first sets in the U.K. to have automatic gland packing gear.

Three of the four alternators are conventionally cooled by hydrogen circulated at 0·5 lb per square inch gauge by integral axial fans on the main shaft ; the fourth† is cooled by high-pressure hydrogen pumped through hollow conductors in the rotor and stator by means of a separate axial blower of gas turbine design, driven from the exciter gearbox (illustrated).

The gear-driven main exciters are air-cooled and each has two field windings. One provides a small constant and negative excitation, while regulation is carried out on the main winding. This device enables low excitation voltages to be obtained without reducing the shunt field current to zero.

† THE ENGINEER, November 15, 1957, page 710.



Semi-outdoor construction of No. 3 boiler bay at Willington " A " power station

All alternators are solidly coupled to the turbine l.p. shaft and generate at 13·8kV. A " Maex " magnetic amplifier automatic voltage regulator is fitted on each machine. An improved electronic supervisory system enables indications of casing temperatures, eccentricity, vibration, differential expansion and clearances to be transmitted for presentation in the control room.

The main differences between the four generators are tabulated below.

	No. 1	No. 2	No. 3	No. 4
Power factor at terminals	0·8	0·9	0·8	0·9
Full load current, A at 13·8kV	5220	4648	5220	4648
Hydrogen cooling pressure, lb per square inch	0·5	3·0	0·5	0·5
Switching voltage, kV ...	132	275	132	275

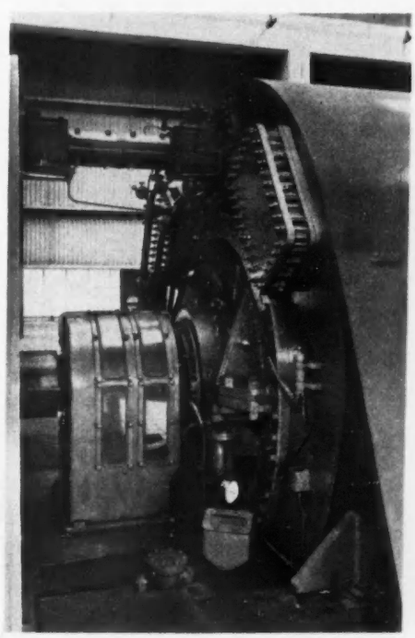
Circulating Water

Condenser cooling water is taken from the Trent, making use of a loop in the river to give the shortest runs of pipework while making the optimum use of the permissible temperature rise. Because of the widely varying seasonal flow in the river and the temperature restrictions imposed by the River Trent Board (temperature rise 15 deg. Fah. and maximum temperature below outfall 86 deg. Fah.), a mixed flow circulating water system is used. There are two 4,500,000 gallon-per-hour cooling towers and they are designed to cope with full load conditions when the river is down to its minimum flow of about 7,000,000 gallons per hour.

In keeping the maximum river temperature below the specified 86 deg. Fah. account must be taken of the proximity of power stations like Drakelow and Castle Donington which also use cooling water from the Trent. Accordingly studies are being made with a view to working out a co-ordinated operational régime for these stations to make the best overall use of the available flow.

At present the circulating water system is designed to use the river flow when it exceeds the station demand of 16,400,000 gallons per hour. At other times any deficit in flow is made up by recirculating water from the cooling towers. In the main pump house any of the four 800 h.p., 4,100,000 g.p.h. pumps can operate with any of the four fine mesh drum screens. Each of the three 1350 h.p. pumps installed in the cooling tower pump house is designed for 3,000,000 g.p.h. delivery against 73ft head.

The water intake culverts, the return culverts from the cooling towers and the outfall culverts consist of about 3650 yards of 72in diameter spun concrete pipes encased in mass concrete with joints at 40ft centres. The culverts between the main pumps and the condensers and between the cooling tower pumps and the cooling towers consist of



Blower drive for circulating hydrogen at 30 lb per square inch in contact with stator and rotor conductors

about 975 yards of mild steel pipe with bituminous lining and external sheathing. The lowest invert level in the culvert system is about 24ft below ground level.

H.P. Steam Pipework

To meet the design conditions of 830,000 lb per hour of steam flow at 1600 lb per square inch and 1060 deg. Fah. the twin mains from the superheater header to the turbine steam chests are of 8in diameter bore with a wall thickness of 1·132in, made of austenitic steel (18 per cent chrome, 12 per cent nickel and 1 per cent molybdenum). Where austenitic steam pipes are connected to the ferritic steam chests and the turbine casings the junction is made by special transition pieces to accept the differential expansion between the two metals. Heaters are fitted on the transition pieces to maintain a temperature of 800 deg. Fah. (avoiding the possibility of reversal of stress) during short periods of shut-down. This temperature is maintained by a "Pyrotenax" element secured to a suitably lagged stainless steel reflector plate.

Each pair of boiler/turbine units is associated with an air-conditioned plant control room. This room provides for automatic control of the boiler, pulverising plant, and the turbine, together with electrical control including synchronising and loading of the generators. Telemetering is used to avoid the introduction of high-pressure steam and water connections in the control rooms.

A separate building connected by a covered bridge with No. 2 turbine room contains the main station and transmission-system control room, where a central logging desk carries the voltage controls for the 275/132kV interbus auto-transformers. A 39-section control board for the 275kV and 132kV switching substation is arranged in "U" formation in front of this logging desk. Control of the main 11kV station auxiliary supplies, including voltage control is effected from a suite of panels behind the logging desk. The associated relay and metering panels are in adjoining rooms.

The busbars for the 132kV and 275kV switchgear are interconnected by two 120MVA OFB cooled, auto-transformers in the 275kV switchyard.

A 10MVA unit transformer is solidly connected to the terminals (13·8kV) of each generator to supply the 3·3kV auxiliaries. Two 15MVA 132/11·8kV transformers supply the 11kV station board for the coal ash plant, and the general service transformers for both the "A" and "B" stations. Two 10MVA 11/3·45kV interbus transformers connect the 3·3kV starting boards for the unit auxiliaries.

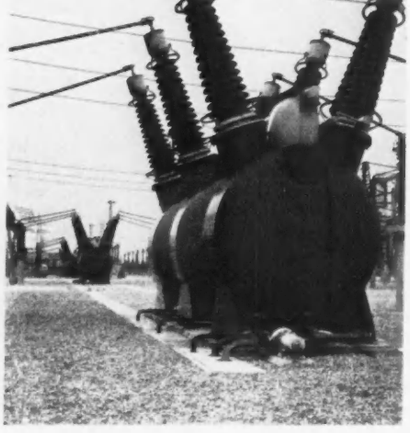
Switchgear

The 132kV outdoor switching station will have sixteen circuit breakers controlling two generators, two 275kV/132kV 120MVA auto-transformers, three 15MVA 132kV/11·8kV station transformers, seven feeders and two bus-couplers. There are skeleton switch bays for a further three feeders, a third 275kV/132kV auto-transformer, and section switch.

The substation has a three busbar arrangement with the main busbar through the centre and the reserve busbar forming an open ring. This layout allows circuits to be brought in on either side of the main bar without increasing the standard switch bay width, thereby considerably reducing the overall length of the substation. The 132kV bulk oil circuit breakers are solenoid-operated with two breaks per phase resistance shunted and a rupturing capacity of 3500MVA. The 132kV isolators are manually operated, with electrical and mechanical interlocks.

The 275kV outdoor switching station (illustrated) has eight bulk oil circuit breakers controlling two generators, three Supergrid feeders, one bus coupler and two 275kV/132kV, 120MVA auto-transformers. There are skeleton switch bays for one future feeder, a bus section switch and a bus coupler. Arrangements have been made to extend the substation to accommodate switchgear for the control of the two 200MW sets in the Willington "B" power station, and a third 275kV/132kV auto-transformer.

The bulk oil circuit breakers have a rupturing capacity of 7500MVA with four breaks per phase resistance shunted. They are pneumatically operated but may be closed slowly for maintenance purposes by means of built-in hydraulic jacks. The 275kV isolators are electrically operated with electrical and mechanical interlocks. Bus-bar selection and section isolators are remotely controlled from the station control room.



275kV oil circuit breakers in the switching station at Willington "A" power station

Connections between the two generator transformers, switched at 132kV and the substations are made by one trefoil group per transformer of single core oil-filled cable 0·45 square inch per phase. The 132kV connections from the low voltage side of the 275kV/132kV auto-transformers to the 132kV substation are made in similar cable but having a section of 0·55 square inch. The connections from the two generator transformers, switched at 275kV, are made by single overhead conductors of 0·4 square inch copper.

The auxiliary supplies are grouped into unit boards and station boards for distribution purposes and are supplied from the various unit and station auxiliary transformers.

The 11kV auxiliary switchgear is indoor oil-immersed single-busbar horizontal-draw-out equipment with a rupturing capacity of 350MVA. The 3·3kV auxiliary switchgear is indoor airbreak single-busbar horizontal-draw-out gear with a rupturing capacity of 150MVA. The 415V contactor switchgear is air-insulated air-break direct-on-line with a rupturing capacity of 25MVA. Metalclad air insulated switch fuse gear is used for supplies to the general services, with the incoming supplies to the switch boards controlled by air circuit breakers.

The total installed capacity of the motors in the station is about 65,811 h.p. Motors above 130 h.p. are switched direct at 3·3kV. The essential standby motors connected with the turbine oil and hydrogen systems operate from the main station batteries. Most of the motors are squirrel-cage motors started direct on line. All essential auxiliary motors can be remotely controlled from the plant control rooms.

Main Contractors

The main contractors for Willington "A" station are listed below.

Civil Engineering Works: Site clearance, foundations for building and plant, railway sidings and roads: Marples Ridgway and Partners, Ltd.; Ash pipeline construction, Crowley Russell and Co., Ltd.; Structural steelwork, Edward Wood and Co., Ltd.; Building superstructure, Marples Ridgway and Partners, Ltd.; Reinforced concrete chimneys, Tileman and Co., Ltd.; Circulating water system and pipework, Marples Ridgway and Partners, Ltd.; Spun concrete pipes, Stanton Ironworks Company, Ltd.; Steel pipes, Redheugh Iron and Steel Company (1936), Ltd.; Flexible couplings, Victaulic Company, Ltd.; C.W. screens, J. Blakeborough and Sons, Ltd.; C.W. valves, J. Blakeborough and Sons, Ltd.; C.W pumps, Drysdale and Co., Ltd.; C.W. cooling towers, Davenport Engineering Company, Ltd.; C.W. cooling tower pumps, Drysdale and Co., Ltd.

Mechanical Plant: Turbo-alternators and condensing plant, English Electric Company, Ltd.; Boiler plant, International Combustion, Ltd.; Feed pumps, main, Mather and Platt, Ltd.; Feed pumps, booster, Mather and Platt, Ltd.; Instrumentation, controls, panels, desks, Electroflo Meters Company, Ltd.; Coal handling plant, New Conveyor Company, Ltd.; Coal sampling equipment, The Birtley Company, Ltd.; Mobile coal moving equipment, Jack Olding and Co., Ltd.; Cranes: turbine house crane, John Smith (Keighley), Ltd., and Vaughan Crane Company, Ltd.; C.W. pump house crane, cooling tower pump house crane, ash grabbing cranes, workshop and stores cranes, John Smith (Keighley), Ltd.; Ash pump house crane, Reed Crane and Hoist Company, Ltd.; Stator lifting gear, The Clyde Crane and Engineering Company, Ltd.; Lifting tackle, G. Hunter (London), Ltd.; Road weigh bridge 30-ton, Ashworth Ross and Co., Ltd.; Ash handling plant, Babcock and Wilcox, Ltd.; Ash pipeline, Stanton Ironworks Company, Ltd.; L.P. pipework, Aiton and Co., Ltd.; L.P. valves, J. Blakeborough and Sons, Ltd.; H.P. pipework, Aiton and Co., Ltd.; H.P. valves, Dewrance and Co., Ltd.; Circulating water chlorination plant, Wallace and Tiernan, Ltd.; Water filtration plant, Paterson Engineering Company, Ltd.; Water softening plant, The Neckar Water Softener Company, Ltd.

Electrical Plant: Generator and station transformers, English Electric Company, Ltd.; Auxiliary transformers (1·5–10MVA), Yorkshire Electric Transformer Company, Ltd.; Auxiliary transformers (200–250kVA), Transformers (Watford), Ltd.; 132kV switchgear, General Electric Company, Ltd.; 275kV switchgear, British Thomson-Houston Company, Ltd.; Cabling, Pirelli-General Cable Works, Ltd.; 132kV/275kV auto-transformers, Metropolitan-Vickers Electrical Company, Ltd.; 11kV and 3·3kV switchgear, English Electric Company, Ltd.; 415V contactor gear, Brookhirst Switchgear, Ltd.; 415V switchgear, English Electric Company, Ltd. (Liverpool), and Lancashire Dynamo Switchgear, Ltd.; 13·8kV alternator connections, British Insulated Callender's Cables, Ltd.; Batteries, rectifiers and d.c. switchgear, Siemens Edison Swan, Ltd.; 11kV station transformer cables, Pirelli-General Cable Works, Ltd.; Auxiliary power control and instrument cables, Johnson and Phillips, Ltd.; Alarm equipment, Clifford and Snell, Ltd.; Telephone equipment, Standard Telephones and Cables, Ltd.; Staff locator displays, Clifford and Snell, Ltd., and General Electric Company, Ltd.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

STEEL WIRE FOR COLD FORGED HIGH-TENSILE BOLTS AND SIMILAR COMPONENTS

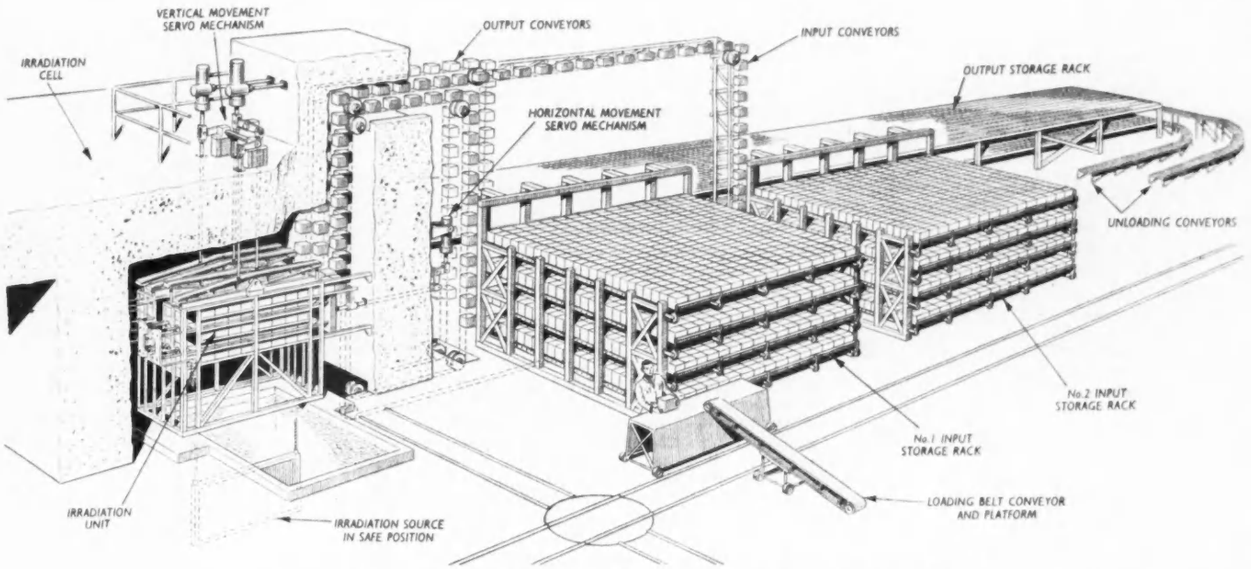
No. 3111 : 1959. Price 4s. 6d. Six types of steel wire suitable for the manufacture of high-tensile bolts which are specified in this publication comprise : one carbon steel and five alloy steels, four of which are also to be found in B.S. 970, En series. Chemical composition is specified for each type ; and allowance is made for the selection of alternative carbon and manganese ranges to meet required hardness values. Mechanical tests (" tensile " and " hardening ") are also specified.

In some respects the standard is a relaxation of 2 S 100, " Inspection and Testing Procedure for Aircraft Steels " (Section 11), since there is provision for agreement between purchaser and manufacturer on a limit of decarburisation.

COPPER SULPHATE TEST AND VISUAL EXAMINATION OF HOT DIP GALVANISED AND SHERARDISED COATINGS

No. 729 : 1959. Price 3s. In this revised publication, the range of articles has been specified with size limitations for larger fabricated articles, and for grey and malleable iron castings, a further standard is in preparation. It includes bolts, nuts and other threaded articles of similar size ; articles fabricated from strips, bars or tubes ; and castings, angle brackets and structural shapes.

The copper sulphate test is now presented in a simplified form, and mention is made in an appendix of electronic thickness gauges which, whilst potentially valuable, are not yet felt to have attained a degree of development comparable with the copper sulphate test.



Outline of pilot plant for irradiation processing at the Wantage laboratories of the A.E.R.E.

Pilot Plant for Gamma Irradiation

PROGRESS by the United Kingdom Atomic Energy Authority towards the commercial-scale use of intense radiation for industrial purposes has now reached the stage at which a pilot plant is being built for operation by the end of this year. It is expected to be the first of its kind and size in the world.

The new plant is being built at the Wantage Radiation Laboratories for the Technological Irradiation Group of the Isotope Research Division, Atomic Energy Research Establishment. Work on the useful employment of the large quantities of radioactive material which will become available as a result of the nuclear power programme has been in progress for some years, and this new plant will enable industrial firms already investigating the technical merit and commercial potentialities of irradiated materials to carry out full-scale trial runs of irradiation processes, such as the sterilisation of medical equipment and the disinfestation of packaged products.

The general arrangement of the plant and the flow system are illustrated here. The whole plant occupies an area of about 10,000 square feet and includes storage of material both before and after processing, all the mechanical handling plant and the irradiation cell which itself occupies roughly 1000 square feet including massive concrete shielding walls. The plant is based on a unit package size of approximately 1 cubic foot and packages will be handled continuously and automatically from bulk store through the equipment and into the treated material store. To ensure full utilisation of the capital investment, particularly of the source, which is continually radiating and decaying, the plant will operate twenty-four hours per day. Carefully designed interlocks and control devices are being incorporated to prevent any health hazard and to ensure the correct radiation dosage.

The cell has been designed to house 500,000 curies of Cobalt 60, but will be loaded initially with 150,000 curies, which will provide a throughput of 7 megarad-tons per day.* As an example, in twenty-four hours 3 tons of medical products or imported animal fibres could be rendered sterile, since a sterilising dose is of the order of 2½ rads.

The contract for the detailed design and construction of the mechanical handling and storage equipment of the pilot plant at Wantage has been let to the Owen Organisation. The main companies within that Group who are concerned are the parent company, Rubery Owen and Co., Ltd., Darlaston, and Electro-Hydraulics, Ltd., at Warrington. Other companies within the Group will also contribute.

The design and manufacturing team built up by the Owen Organisation is working in close collaboration with the Engineering Division at Harwell who have established the general design and specification to the requirements of the Technological Irradiation Group.

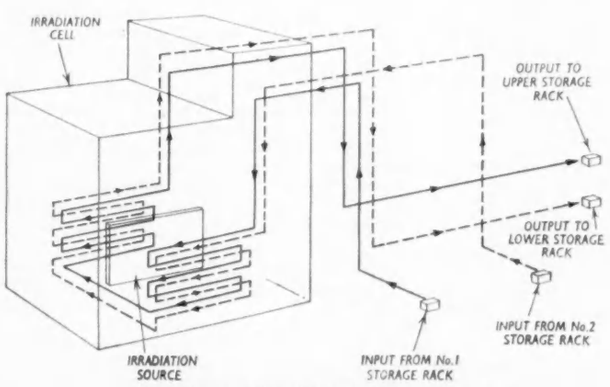
* The rad is the unit of radiated energy absorbed by the material : 1 rad = 100 ergs per gramme ; 1 megarad = 10^6 rad.

Prevention of Undercooling in Marine Condensers

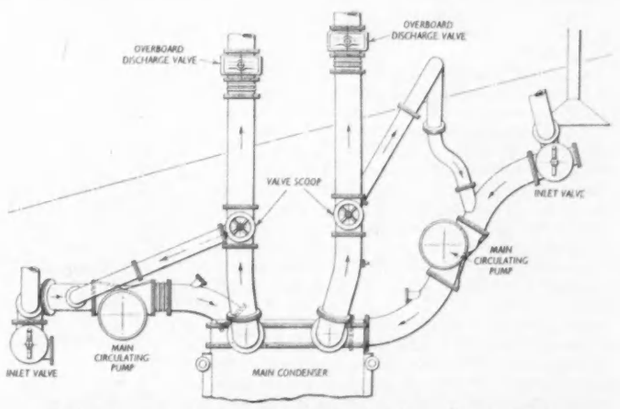
WITH the object of preventing undercooling in condensers on board ship, John Brown and Co. (Clydebank), Ltd., has been engaged on certain investigations which have resulted in the adoption of a system of recirculation of condenser cooling water to achieve this purpose. The system, with the co-operation of the B.P. Tanker Company, Ltd., was tested during the trials, earlier this year, of the latter company's tanker " British Judge."

One of the main objections put forward against the adoption of a.c. motor-driven auxiliaries was the lack of control of fans and circulating pumps as compared with d.c. drive. However, initially, this difficulty was overcome by introducing two-speed motors, but at considerable cost, and recent economic appraisals have tended to show that this could not be justified except in a vessel having a very wide range of power. Thus, current practice, in tankers, which operate under steady steaming conditions, is to have a single-speed motor for these particular units.

Due, however, to the considerable variation in sea water temperature which may be experienced in tanker service, the lack of control for circulating water conditions in the condenser may give rise to a considerable degree of undercooling, with consequent loss of performance ; in some instances it is not appreciated that a high vacuum in itself may mean a loss of efficiency. To operate at maximum efficiency it is essential to run a turbine plant as close as possible to the design conditions and maintain the design vacuum. This is illustrated overleaf where a particular example of loss in efficiency is plotted


IRRADIATION CELL
OUTPUT TO UPPER STORAGE RACK
OUTPUT TO LOWER STORAGE RACK
INPUT FROM No.2 STORAGE RACK
IRRADIATION SOURCE
INPUT FROM No.1 STORAGE RACK

Flow diagram of irradiation processing plant



Recirculation system to prevent undercooling in marine condensers

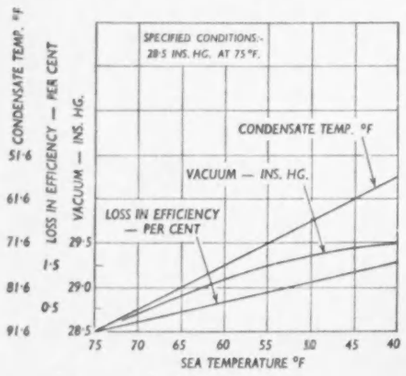
TABLE—*Recirculation of Condenser Discharge to Pump Suction*

Specified design conditions : 28·50in Hg vacuum at 75 deg. Fah. sea temperature. Full power trial. Forward pump off. Aft pump on low speed.

Reading number	By-pass valve, No. of turns open	Discharge valve, No. of turns closed	Vacuum, inches Hg	Saturation temperature, deg. Fah.	Condensate temperature, deg. Fah.	Under-cooling, deg. Fah.	Sea-water temperature, deg. Fah.	Condenser circulating water			Circulating pump	
								Inlet, deg. Fah.	Discharge, deg. Fah.	Rise, deg. Fah.	Amperes	R.p.m.
1	Full open	40½...	28·48	92·0	91·5	0·5	49·5	67·0	88·0	21·0	70	500
2	Full open	40½...	28·48	92·0	91·5	0·5	49·5	67·5	87·5	20·0	70	500
3	Full open	Full open	28·85	83·2	81·0	2·2	49·5	55·0	76·0	21·0	70	500
4	Closed	Full open	29·15	74·0	71·0	3·0	48·5	47·0	64·0	17·0	70	500

against sea water temperature. Apart from this aspect of undercooling, higher vacua may have an effect on the life of the turbine due to the steam leaving conditions not conforming with design and having a possibly higher moisture content, causing erosion on blades and casings.

While a degree of control can be obtained by closing in the circulating water overboard discharge valves when the sea water drops below design temperature, this is not sufficient as it



Graph of condensate temperature, vacuum and per cent loss in efficiency against sea temperature

means that the circulating pump is then working away from its design condition of efficiency and the reduction in the quantity of water passing through the condenser may cause a loss of vacuum. It was with these difficulties in mind that John Brown and Co. (Clydebank), Ltd., have been exploring the possibility of recirculating the condenser sea water discharge and by agreement with the B.P. Tanker Company, Ltd., a scheme was evolved for installation in the "British Judge."

The arrangement of the recirculating piping is shown on page 395 : a recirculating pipe is taken to the suction side of each pump from each main circulating discharge pipe in the condenser.

Of particular interest is that the recirculating valve is in the form of a retractable scoop, thus serving the double purpose of effectively diverting the water to the recirculating pipe and maintaining resistance in the discharge system and preserving the circulating pump characteristic. The trial results are shown in the table above.

The design condition for the condenser was a vacuum of 28·5in Hg at a sea water temperature of 75 deg. Fah. During the trials conducted on the Clyde the sea water temperature was about 49 deg. Fah.

From the table it can be noted that by means of the recirculating connection, the inlet temperature of the water to the condenser was increased from 49·5 deg. Fah. to 67 deg. Fah., with a vacuum of 28·48in. Under this condition the amount of undercooling was 0·5 deg. Fah., while with no recirculating, as shown in reading No. 4, the undercooling was 3 deg. Fah. The combined effect of undercooling and depression of condensate temperature resulting from increase of vacuum amounting to 20·5 deg. Fah. could represent an increase in fuel consumption of about 1 per cent.

In this vessel the valves were arranged for manual operation, but the system lends itself to complete automatic control and this can be accomplished by the temperature differential between the steam at inlet to the condenser and the condensate at the bottom of the condenser.

Television and Sound Equipment

AT an exhibition in London last week of equipment for television and sound broadcasting studios, Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex, showed a new image orthicon camera channel with a camera suitable for 3in and 4½in tubes. The complete channel, designated "BD863," comprises the camera itself, a camera control unit and panel, power supply unit, and picture and waveform monitor. Combined with the high sensitivity of the 4½in orthicon, the camera weight of under 100 lb makes the equipment particularly suitable for outside broadcasts. This weight reduction has been achieved by simplifying the electronic circuitry incorporated in the camera itself by transferring some controls and circuits not often required by the cameraman to the remote control position. The camera (Fig. 1) contains only twelve valves and the circuits are carried on small printed sub-assemblies which are plugged into the main frame. These have two screened busbars running along the edges to provide low-impedance h.t. points, earth points and heater supplies, while also contributing to rigidity.

The camera control unit and power supply unit use printed-circuit assemblies mounted side by side in cases in the same 19in standard rack. The boards have plug and socket interconnections to allow easy removal of individual units, and are attached to each side of vertical central panels carried at top and bottom by ball bearing slides so that a complete assembly can slide out of the printed wiring case. Associated with the camera channel is a new picture and waveform monitor with 14in picture and 5in waveform tubes. Strobe facilities enable any line of the scan to be isolated for examination.

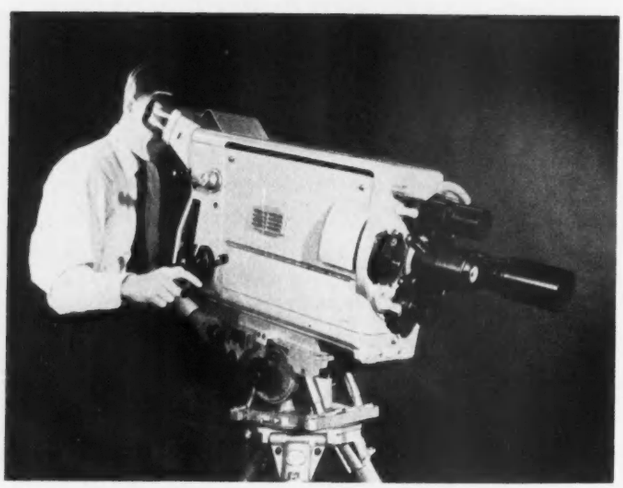


Fig. 1—Image orthicon television camera for studio and outside broadcast use. The weight is under 100 lb

A further example of reduction in size by the use of printed circuitry was seen at the exhibition in the "BD886" vision distribution amplifier, in which four independent plug-in video amplifiers provide three outputs each from one bridging input. The units slide in and out of a 19in rack. All input and output connections are made through one multi-way plug at the rear of each unit, and when a unit is withdrawn for servicing or replacement the line serving it is automatically correctly terminated on a printed circuit board. An alternative version of the unit is available as a pulse-distributing amplifier.

A somewhat similar range of amplifier units (Fig. 2) is made for audio use and allows the construction of very compact broadcast studio control consoles. It is possible to provide all types of studio control required by sound broadcasting services in two standard control desk shells accommodating twelve and twenty-four amplifier units respectively. The units ("BD954" series) employ printed circuit techniques and plug in on runner assemblies. Most of them are built to standard dimensions of 2 $\frac{13}{16}$in by 5in by 11 $\frac{9}{16}$in.

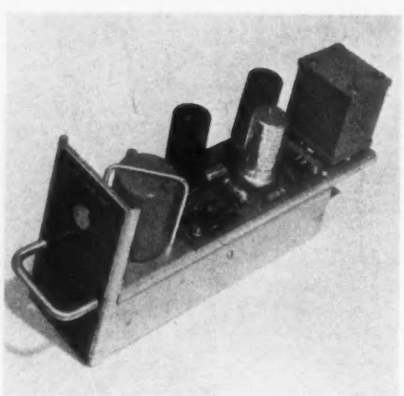


Fig. 2—Plug-in audio amplifier unit incorporating printed circuits for building into broadcast sound control desks

A "transistorised" portable amplifier and mixer for outside sound broadcasts, which is now in production after overseas trials, was also seen. Provision is made for mains or external battery supply and an internal battery of mercury cells is brought into use automatically by the operation of a relay in case of mains failure. The amplifier measures 12in by 6in by 9in and weighs under 15 lb, including supply unit and battery.

Exhibits arranged by the English Electric Valve Company, Ltd., included the 4½in orthicon tube used in the "BD863" camera channel described above, which gives a signal output of between 10 and 20 microwatts, vidicon tubes, travelling wave tubes and a 200kW klystron oscillator for tropospheric scatter communication systems.

SHORTER REPORTS

Weeks Hall, Imperial College

WEEKS HALL, the first of several halls of residence for Imperial College in Prince's Gardens, London, was formally opened on September 30 by Lord Knollys, chairman of Vickers, Ltd. The hall, for which Vickers, Ltd., made a benefaction of £150,000, is named after Lord Weeks, who was chairman of the company from 1949 to 1956. The ceremony was attended by sixty guests. The opening of the hall marks the completion of the first stage of the College's scheme for the development of Prince's Gardens as a residential and social precinct. Although it is a separate building, it has been designed to link architecturally with future developments along the north side of the Gardens. We are informed that it has been planned "to create a human, domestic atmosphere for the students" within a large building. To this end, study-bedrooms are grouped in "sets" of eight on each floor, each set with its own bathroom, shower, lavatory and pantry. The Warden and his family will live in a penthouse flat on the ninth floor. The ground floor includes a common room, a dining room and a conference room.

Chiswick Flyover

THE Chiswick flyover was opened to traffic on September 30. It is the first major two-level highway scheme completed in the London area since the war. The works extend for about half a mile, and comprise a through road linking the Cromwell Road extension to the Great West Road without interference from cross-traffic. This through road is carried over a new roundabout which is 400ft in diameter; the roundabout has a 40ft wide carriageway and is at the junction of the North Circular Road, Chiswick High Road, the road to Kew Bridge, and the Great West Road. Traffic will be distributed to these roads by four slip roads joining the roundabout at ground level. The present junction is now used by 40,000 vehicles a day. The through road of the flyover has dual 24ft wide carriageways separated by a central reservation.

The flyover embodies two bridges. The main bridge consists of four freely supported square spans, each 125ft, with a width of 59ft between parapets, carrying the through road over the new roundabout; and a bridge over Wellesley Road, east of the new roundabout, has a 70ft single skew span and is 124ft wide between parapets, as the slip roads meet the through route at this point and four 24ft carriageways are required.

The approaches of the flyover and the section between the bridges are formed on embankments retained between mass concrete walls, brick-faced with *in situ* concrete copings forming guard verges about 4ft wide to the through road and slip road carriageways. The embankment filling consists of well-graded mechanically stable gravel (hoggin).

Carriageway construction consists generally of a reinforced concrete base slab 10in thick, with a surfacing of 3½in of hot rolled asphalt. All structures of the flyover have been designed for Ministry of Transport standard highway loading and for the 180-ton abnormal live load.

The superstructure of each span of the main bridge consists of fifteen concrete beams placed side by side, each beam being precast in three sections. The end sections are about 38ft long and the centre sections 48ft long, each section weighing about 33 tons. The minimum twenty-eight days cube strength of the concrete was 7500 lb per square inch. The beam units, which are provided with mild steel secondary reinforcement and certain prestressing cables post-tensioned by the Freyssinet system during manufacture, are of inverted "T" section with a narrow top flange and with transverse diaphragms cast integral with the unit. The bottom flange of each roadway unit contains eighteen 1¾in diameter straight ducts formed by casting in steel sheathing. The ducts terminate in the end blocks of the end units against steel plates cast into the end faces and drilled with a corresponding number of holes. The outer beams of each span are of "U" section, constructed of concrete with grey Cornish granite aggregates. The exposed vertical face has been lightly bush hammered.

The sections were erected directly on the permanent bearings on piers and abutments and on temporary rollers supported on steel trestles on either side of the transverse joints between them. These joints are nominally 3in wide and continuity of the ducts across the joints was maintained by short lengths of rubber tube clipped to the ends of steel tubes projecting from the beams. The joints were filled with rapid-hardening cement concrete. Each complete beam, after assembly, was post-tensioned by the Freyssinet system when the concrete in the joints had attained a cube crushing strength of at least 6000 lb per square inch—usually three days after casting. Each duct contains a cable of twelve high-tensile wires, 0·276in diameter, and the Freyssinet anchorages are on the outside of the steel end plates. Each beam was stressed from one end with a load of 113,000 lb per cable, and the ducts pressure-grouted with neat cement colloidal grout.

An *in situ* reinforced concrete slab was cast at the level of the top of the beams, and the deck was prestressed transversely by the Gifford-Udal system with cables threaded through the webs and transverse diaphragms of the beams. The anchorages are located in the inner webs of the outer "U" beams.

A loading test to failure of one complete roadway beam was made, as noted in THE ENGINEER of January 2, 1959, page 21. The Ministry of Transport and Civil Aviation's consulting engineers were Harry Brompton and Partners, and the main contractor was the Alderton Construction Company.

Contractor's Statement About Chiswick Flyover

THE construction of the Chiswick flyover is briefly described in the preceding article. The following statement, which we reproduce without alteration, has been made by the main contractor for the flyover.

"The directors of the Alderton Construction Company, Ltd., are very proud to hand over to the public Britain's first flyover after two and a half years of arduous work, undertaken whilst continuously surrounded by heavy traffic. We have faced on this contract every possible obstruction from the earliest days, but nevertheless we have been able to complete the work on time, although an extra £120,000 of work has been added to the original contract.

"(1) Instead of our being given possession of buildings for demolition on March 1, 1957, as on the specification, we obtained possession on October, 1957, after a delay of eight months.

"(2) We were delayed for six months in obtaining access to Brentford Market as it took the authorities this time to obtain possession of a few rotten orange-boxes which we eventually burnt.

"(3) In December, 1957, we were four months ahead of schedule, but had to dismiss half our labour force as the authorities would not agree to close 500 yards of Cromwell Road ahead of programme. Total delay seven months.

"(4) A further month's progress was lost while special 2½in thick hand-finished bricks were manufactured to satisfy an architectural whim. 1,500,000 million bricks used on the contract.

"(5) A rigid construction programme for the work was drawn up by the authorities, and at no time have we, as contractors, been allowed to speed up the progress of the work, which we could have done.

"(6) We emphasise that we have been in no way responsible for the design of this flyover which, with its massive retaining walls and vast quantities of filling, cannot be considered a modern structure. We have had many distinguished visitors from this country and overseas who have expressed similar opinions.

"In our view, with a modern design, the flyover could have been built in half the time and for half the cost.

"As the Chiswick flyover approached completion, we naturally endeavoured to find another interesting contract for our organisation and men. In July, 1959, we submitted a tender for the new bridge over the River Thames at Staines. At a public dinner this summer the Minister of Transport stated that he 'welcomed new ideas, new techniques and new ways of getting the maximum amount of construction for the minimum amount of money.' Such were his words and on them we recently tendered for the new Staines bridge over the Thames—incidentally the first bridge over the Thames for over twenty years. In this case we tendered not only for the official design, but also submitted an alternative. This alternative, although identical in its outward appearance, gave a saving of nearly half the cost, i.e. of about £200,000, simply by using modern design and construction methods embodying prestressed concrete and precasting. Not only would this be cheaper but the bridge would be completed about a year earlier by the use of this method.

"Both of our tenders were rejected without discussion, although our tender for the official scheme was the lowest received. Nevertheless, our offer remains open and our claim to save time and money stands good.

"Overseas, it is now almost everywhere the practice to link design and construction where bridges and marine work are concerned, since design and construction depend so much on each other to produce an economical and light structure with speedy construction. In the U.K. contractors who are capable of undertaking design are not encouraged, and so we should like to emphasise that our group of companies is pioneering the principle set out above in the general interests of British engineering.

"The Central Electricity Generating Board, for which we are effecting a major power station design in Essex, always invites contractors to submit alternative proposals. In this way the C.E.G.B. saves the public vast sums of money and encourages the contractor to put forward his best and most economical ideas.

"There is no doubt that a more up-to-date approach to bridge construction in this country, drawing on all available experience and know-how of contractors, road users and designers, would save the country millions of pounds and result in speedier construction."

Industry and the Royal Society of Arts

THE ROYAL SOCIETY OF ARTS has decided to admit limited liability companies into association with it—the first time since its foundation in 1754 that trading concerns have had an opportunity of being directly connected with the Society. It is hoped by this means to establish a closer link between industry and commerce on the one hand and the work of the Society on the other. The wide scope of the Society's activities is not generally appreciated, but it is the only unspecialised body of its kind in the country which seeks to promote "arts, manufactures and commerce." For a minimum annual subscription of twenty guineas companies can enjoy certain privileges, full details of which are available from the Secretary, John Adam Street, London, W.C.2.

Institute of Marine Engineers

ON October 6, in the Memorial Building, this year's president, Sir William Wallace, delivered his address to the Institute of Marine Engineers, and broadly recounted his experiences during his fifty-five years in engineering. He recalled his early days at sea and his coming ashore after only a short sea experience, a fact which he linked with the present-day difficulties of retaining certificated engineers at sea. This problem, he thought, was of paramount importance to-day in view of the need for well-trained personnel to take charge of increasingly complicated machinery. Improvement in status, remuneration, living conditions had not proved to be the solution of the problem, which he thought was closely related to questions concerning family life. Another point made by Sir William was the need to assist engineers to get in the regulation sea time to help towards obtaining their certificates. In making a start ashore, the president commented that he joined at zero salary the company with which he had been so long associated, and advanced to more comfortable circumstances later. From this experience he advocated that young men should forgo immediate prospects of gain in favour of the long-term view of attaining a more substantial reward later. Sir William went on to relate some of the history of Brown Brothers and Co., Ltd., and dwelt particularly upon the development of the company's stabiliser gear, from the early work on the "Isle of Sark," and the equipping of H.M. sloops and destroyers, to the successful application of the system to the P. and O. liner "Chusan," which led to the equipment being fitted to many liners including the two "Queens."

Scientific Instruments Convention

THE eighth convention of the Scientific Instrument Manufacturers' Association will be held in Brighton, at the Hotel Metropole, from October 22 to 24. Announcing, at the Association's headquarters, 20, Queen Anne Street, London, W.1, on September 30, that the theme of the convention would be "Instruments of Destiny," Mr. Laurie A. Woodhead, President of the Association, said that this country had been first in the field in many directions and it was essential to look forward. In these days, when so many countries were producing their own equipment, one way in which we could still lead was by being first in the field again and again. Our asset was that we had brains to sell. In conclusion, Mr. Woodhead introduced Captain R. A. Villiers, the newly-appointed director of the association.

The proceedings of the Brighton convention will be conducted by four panels considering the following subjects: "Instruments of the Future" (chairman, Mr. H. C. Pritchard, Cambridge Instrument Company, Ltd.); "Future Materials and Production Techniques" (chairman, Mr. T. W. Clifford, Taylor, Taylor and Hobson); "Organising for the Future" (chairman, Mr. John Bolton, Solartron Electronic Group, Ltd.), and "The Individual and the Company" (chairman, Mr. H. C. Mayer, Griffin and George, Ltd.). Panel sessions will begin at 9.30 a.m. on October 23, when there will be two in the morning and one in the afternoon, and finish on Saturday, October 24, at 11 a.m. Each will last one-and-a-half hours and will discuss subjects introduced in informal talks by different speakers. Technical topics for discussion by panels Nos. 1 and 2 include the nuclear age, the space age, travel, medicine, materials, instrumentation conditions in ballistic missiles and satellites, and electronic components of the future. Panels Nos. 3 and 4 will be concerned with business organisation and personnel relations.

Simplified Commercial Computer Code*

A SIMPLIFIED code known as "Commercial Translator," has been developed by I.B.M. United Kingdom, Ltd., 101, Wigmore Street, London, W.1, for the programming of electronic computers for commercial problems such as payroll, inventory and production planning. The development of a code for commercial use was complicated by the lack of standard business terminology, and began with an analysis of a large number of commercial problems already being processed by electronic computers. As a result of this analysis, a code was constructed in which these problems could be stated in terms of fifteen basic computer functions (arithmetic, logical decision making, editing and other data handling operations). "Commercial Translator" consists of normal English words which will be converted inside the computer into detailed machine instructions. It can be used with the larger existing I.B.M. computers, and will be compatible with future I.B.M. computers. The code is so like normal English that a person completely unfamiliar with computer programming can be trained to use it in a matter of days, merely by learning a few rules of vocabulary, sentence formation, use of suffixes and punctuation. A typical statement in this new language to describe the procedure for re-ordering when stocks are low might run as follows: "If stock level is less than 1000 or reserve level is zero, then set order amount equal to 5000 minus stock level; move order record to order file; go to next item."

* Enter No. E3983 on Reply Card.

British Industrial "Maser" in Operation†

A "MASER" amplifier (microwave amplification by stimulated electromagnetic radiation), thought to be the first working assembly to be built in this country by an industrial laboratory, came into operation recently at the Mullard Research Laboratories, Salfords, Surrey. Construction of the "Maser" and investigation of its properties and performance has been carried out in the laboratories' solid state physics division where considerable work on semiconductor effects at low temperatures is being done under the leadership of Dr. J. C. Walling.

"Maser" amplifiers are a recent development which make use of the natural oscillations of the paramagnetic ions in certain crystalline substances—ruby being used in the present equipment. One of their chief uses lies in their ability to give useful amplification of very weak radio signals without producing unwanted signals which would otherwise swamp them. One application of the device which has already proved successful in radio astronomy is for the amplification of very small signals from distant stars.

The Mullard "Maser," which was constructed in co-operation with the Royal Radar Establishment, Malvern, operates at a wavelength of 10cm in the "S" band and at a temperature of 1·7 deg. K. (approximately −271 deg. Cent.), using liquid helium. Investigations to attain higher frequencies and operating temperatures are being actively pursued at Salfords and Dr. K. Hoselitz, head of the solid state physics division, says there is a possibility of "Maser" amplifiers operating at higher frequencies at room temperatures in the future.

† Enter No. E3984 on Reply Card.

Progress at Kingsferry Bridge

A DELICATE operation in the building of the new Kingsferry road and rail bridge between the Isle of Sheppey and the Kent mainland was carried out on Friday and Saturday, October 2 and 3, by the steelwork contractor. There are three steel spans with reinforced decking on both the Kent and Sheppey sides of the bridge, with a navigation opening of 120ft, which is spanned by a steel lifting span permitting the passage of ships. The overall length of the steel bridge is 650ft. The operation now begun is the transfer of the navigation span from its temporary position on the Kent approach to its permanent position across the navigation channel. During this operation the weight of the span is approximately 260 tons.

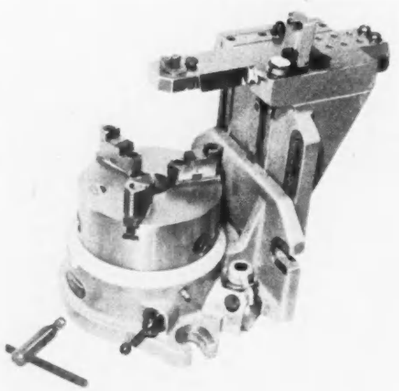
The method adopted to bring the span into its final position involved rolling the span forward over the full length of the Kent approach until its nose reached the Kent tower. At this point the weight of the nose of the span was transferred to sets of rollers mounted on the Kent pier.

When this was completed, the nose of the span was again moved forward across the navigation channel until it neared the point of balance on the rollers. At this point two tackles, each of 60 tons capacity, suspended from the top of the Sheppey tower on the other side of the navigation channel, were connected to the nose of the span, with restraining tackle to control forward movement. The span was then again moved forward with its weight carried between the 60-ton tackles and the Kent pier rollers until the nose of the span reached the Sheppey pier. The ends of the span were then connected to the balancing counterweights suspended in the towers, thus securing the span across the navigation channel.

The next step is the raising of the span 75ft to the tops of the piers where completion of the decking will take place, leaving the channel clear for navigation. The consulting engineers for the Kingsferry bridge are Messrs. Mott, Hay and Anderson, and the main contractor is John Howard and Co., Ltd. The steelwork contractor is Dorman Long (Bridge and Engineering), Ltd.

Spacing Attachment‡

WE illustrate below a spacing attachment, for use on drilling, milling, grinding and other machines, made by Jones and Shipman, Ltd., Leicester. On this fixture there is fitted a Pratt chuck with reversible jaws which is indexed by withdrawing a hardened steel plunger from a notched index plate contained within the fixture body. For alternative visual setting purposes, a graduated dial may be used with the plunger locked in a disengaged position by a knurled screw. The three alternative interchangeable master index plates which may be fitted have twenty-four, thirty and thirty-six notches, giving angular settings of 15 deg., 12 deg. and 10 deg., respectively. By inserting masking plates which blank off unused notches, subdivisions of 2, 3, 4, 5, 6, 8, 9, 10, 12, 15 and 18 deg. are obtainable with the index plates. After indexing, a taper ring locking clamp is used to lock the chuck base plate to the main body of the spacer,



Spacing attachment fitted with drilling bracket

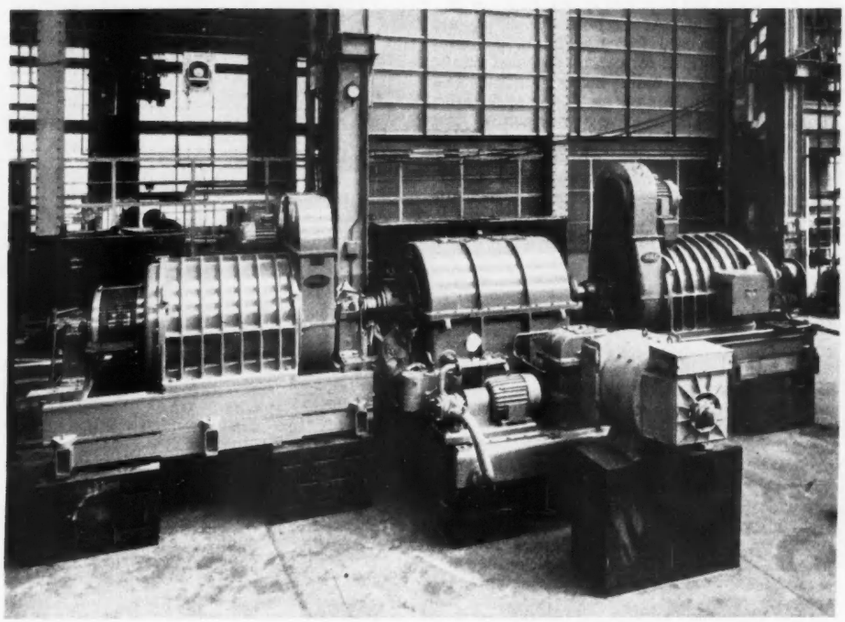
thereby relieving spacing plate and plunger of strain.

Two faces at right angles on the body can be used according to the operation required. For drilling purposes, a separate drilling bracket, containing a range of drill bushes from 0·040in diameter to $^{25}/_{32}$in diameter, is either clamped to the attachment body for face drilling or to a special face plate for peripheral drilling. For milling and grinding operations, a tailstock fitting is supplied.

‡ Enter No. E3986 on Reply Card.

Testing Large High-Speed Motors*

OUR illustrations show an installation developed by The General Electric Company, Ltd., Kingsway, London, W.C.2, for testing large high-speed induction motors and synchronous machines up to 10,000 h.p. at 3000 r.p.m. by a variation of the back-to-back system in which is its condition for generating power. This speed difference is achieved, in the G.E.C. test plant, by using an epicyclic differential gearbox in which the slip energy is provided by a variable speed d.c. motor feeding into the planetary gear. Our first illustration shows the gear unit coupled to two similar large two-pole induction motors and also shows the variable speed, 1500 r.p.m.



Arrangement of the G.E.C. test plant showing two large two-pole induction motors coupled to the differential gearbox for testing

the only power taken from the supply is that needed for the mechanical and electrical losses.

The main requirement for the back-to-back testing of two induction machines is some means of maintaining the required speed difference so that the machine which is motoring can run at its normal sub-synchronous speed while the other machine can run above synchronous speed which

This hand-operated gear unit is coupled to the differential shaft when the plant is used for testing synchronous machines

* Enter No. E3991 on Reply Card.

Ward-Leonard-controlled d.c. motor which supplies the slip energy and varies the loading on the machines being tested. The gear unit, made by David Brown Industries, Ltd., is continuously rated for 10,000 h.p. at 3000 r.p.m., with a maximum shaft differential of 100 r.p.m. (i.e. 3050, 2950 r.p.m.). It is built as a self-contained unit with its own water-cooled lubricating system. The maximum rating for the slip energy motor is 200 h.p. at 1500 r.p.m.

Driving the differential shaft creates a speed difference between the motors by adding revolutions to one and subtracting them from the other. In effect, one motor is braked and develops a torque, while the other is accelerated, absorbs the torque of the motor and delivers power as an induction generator. The loading on the machines is directly proportional to the rotational speed of the differential shaft. The differential shaft motor provides the slip energy or the rotor losses and the only power taken from the supply is that required to cover the stator losses.

The gear unit can be used for testing any similar pair of induction motors, provided their output is reasonably high compared with the gear losses. It is estimated that motors as small as 300 h.p. at speeds up to 3000 r.p.m. could be tested satisfactorily.

Synchronous machines can be tested by coupling a hand-operated gear unit to the differential gear train in place of the driving motor. The point is that a synchronous motor coupled to one main shaft and running at synchronous speed would not necessarily be in phase with a similar machine coupled to the other end when connected to the same supply, but the machines could be brought into synchronism by rotating the hand-operated gear unit. When similar machines have been synchronised, the loading on them can be increased by rotating the hand gear unit (illustrated here), which causes their mechanical phase displacement to alter.

One synchronous machine becomes a synchronous motor and the other a synchronous generator which feeds power back to the supply. The role played by each machine depends on the direction in which the hand-operating gear unit is rotated and the actual loading on each machine depends on the degree of mechanical displacement produced.

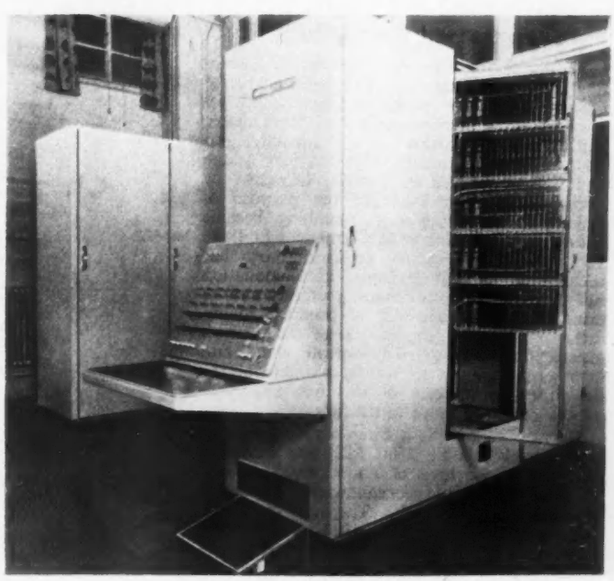
An important characteristic of this testing unit is that, in the event of a sudden removal of the electrical load, the mechanical displacement between each machine remains unchanged, and the load can be reapplied without having to resynchronise the machines. This is particularly advantageous when testing synchronous machines which are controlled by automatic voltage regulators.

Data Processing System Under Test†

THE first production model of the central computing unit of the A.E.I. "1010" data processing system manufactured by the A.E.I. Electronic Apparatus Division, Trafford Park, Manchester, was completed on schedule and is now undergoing tests. This equipment was originally announced as the "Metrovick 1010" and was shown in scale model form at the 1958 Electronic Computer Exhibition in London. A description appeared in our November 28, 1958, issue, page 836. Various items of peripheral equipment are being added and tested with the computing unit (illustrated herewith), which will be installed in a computer centre in the Manchester area by the end of this year. Orders for delivery will not be accepted before early 1961, by which time the first installation will have been running for a year.

An introductory course on the "1010" data processing system was held recently in the Trafford Park Works of A.E.I., and similar courses for firms and organisations which are prospective customers for the "1010" system are to be repeated at regular intervals. Programming courses will be started early next year at the computer centre where the "1010" system will be available for customers and prospective customers, to run and prove programmes written for their own applications. The system has been designed so that a medium-size set

† Enter No. E3992 on Reply Card.



Central computing unit of new data processing system under test

costing about £150,000 can be expanded at will as data processing requirements grow. This is done by the addition of ancillary equipment, without any change to the central computing unit. In this way a powerful and flexible system can be built up which is capable of controlling up to thirty-two peripheral units, such as magnetic tape decks, paper tape and card readers, line printers, inquiry typewriters and paper tape and card punches. Facilities are available for parallel programming, interruption to execute priority work and multiple input and output. The computer is completely "transistorised" and can execute some 70,000 data processing instructions every second.

Positive Displacement Pump*

We have been afforded by Neumo, Ltd., South Coast Road, Peacehaven, Sussex, a detailed explanation of the functioning of the reciprocating positive displacement pumps it supplies for handling corrosive, abrasive and flammable liquids and molten solids such as chocolate. The designed driving medium is air, engendering great safety, but the pump differs from superficially similar designs, such as the "Airhydropump" and the "Hydraflo" in that the valve gear of the motor is not linked mechanically to the piston. Instead, the valve shuttle, which resembles that of the familiar hydraulic servo valve, is moved by the pressure of the working fluid admitted to one or other end of its chamber: this is claimed to show an advantage in that unless a mechanical valve gear can change one side of the ram from supply to exhaust and the other from exhaust to supply simultaneously the motor is liable to stall when running at very low speeds or to fail to start from standstill. During the working stroke the valve is held at full travel by air from the supply to the ram admitted to the end of the valve chamber through a restrictor, but at the end of the ram stroke one of two ports on a branch connecting freely with the valve chamber is opened to exhaust by an annular groove round the ram. The other of the two ports serves to admit air to the chamber and initiate a stroke when it is uncovered by the head of the piston at the end of a working stroke in the opposite direction. With this simple valve gear there is, of course, no attempt to expand the air, cut-off being 100 per cent. Since the valve is connected to the motor only by air ducts, one valve can run a set of motors in synchronism, and if it is arranged that the motor commanding the valve is slowest in completing its stroke the outputs of the separate pumps will be in strict proportion to their swept volumes.

Factory at Kirkintilloch

A new factory has been opened at Kirkintilloch by Archibald Low and Sons, Ltd., for the manufacture of marine and industrial pipework, sheet metal and welded plate fabrications, and "Alaflor" extruded aluminium alloy grid flooring and stair treads. This company, which was first established in Partick, Glasgow, by Archibald Low in 1853 for the purpose of making and installing ship's plumbing, became one of the Steel Group of Companies in 1946. The move to new works at Kirkintilloch has been made to provide larger accommodation suited to modern production methods and to extend the range and size of products manufactured. Kirkintilloch is one of the districts selected for the Glasgow "overspill plan" and in acquiring the 8¼-acre site for the new factory the firm became one of the first industrial establishments to move to the new area.

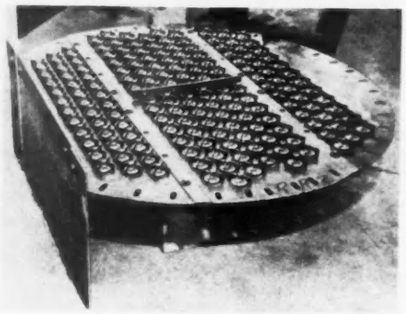
The new factory is a three-bay single-storey steel-framed building 250ft long and having a productive floor area of about 40,000 square feet. Its walls are of sheet sandwich construction in accordance with the Thermal Insulation (Industrial Buildings) Act, 1957, and heating is provided by underfloor hot water coils. The power, gas, compressed air and water services to the working floor area have been arranged to permit a high degree of flexibility in future plant layout with short connections to adequate service supplies when working on large assemblies on any part of the floor.

The main production of the firm is divided broadly into three classes of work, each of which is concentrated in one bay. The pipework bay is equipped for the fabrication of steel pipework in all sizes up to 15in nominal bore by 20ft long, and copper pipework up to 12in bore by 12ft long. At the head of this bay are pits which are used for pipe filling purposes when this is required for certain specified classes of bending. The main heavy bending and welding plant is situated along the wall down one side of the bay to leave a wide central area available for laying out large coil and other pipe assemblies. A hydraulic test section at the lower end of the shop is equipped for supplying water at up to 1250 lb per square inch for testing purposes.

The cold bending equipment installed covers pipes up to 6in nominal bore with radii down to twice pipe diameter, and gas-fired hearths are installed for fire bending steel pipes up to 15in nominal bore and copper work up to 12in nominal bore. Pipes rolled from steel plate up to ¾in thick and welded are made in diameters from 15¼in and upwards in this shop. The firm is now also in a position to supply P.V.C. piping up to 6in bore to special order.

The central bay of the new factory is laid out for the manufacturer of "Alaflor" extruded aluminium grid flooring and stair treads. This material is delivered in extruded bars 9in and 6in wide and is punched with either round or rectangular holes, according to the required duties, on specially tooled presses of 40 tons and 60 tons capacity. It is cut into lengths on a Wadkin cross-cut saw and welded into the required widths and shapes for platforms, catwalks, stairs, engine-room gratings, &c., on four "Argonarc" sets.

New equipment installed in the sheet metal working bay has considerably increased the firm's capacity for this class of work. A new combined guillotine and press brake at the head of this bay has a capacity of 175 tons and cuts 8ft wide plate up to ⅜in thick and 10ft wide plate up to ⅝in thick. Supplementing this machine for heavy gauge cylindrical vessel manufacture is a new set of initial pinch plate rolls for handling similar sized plates. With these and the other plant and manipulators installed in the new shop, the firm is now producing calorifiers, tanks, condensers, evaporators, ducting, bed-plates and other welded plate work to special requirements in sizes weighing up to 7½ tons.



"Flexitray" bubble deck

A recent addition to the products of the firm is the "Flexitray" bubble deck for separation columns which is now being made under licence from the Koch International Corporation of the United States. One of these trays, which are specifically designed for each application, can be seen in the accompanying illustration. The tray has a series of caps about 2in diameter which lift during processing and operate like check valves. The degree of lift is limited by four-legged "spiders" which also serve as guides. These cap assemblies are clinched securely to the deck at 3in to 6in centres, similar to bell-cap trays. Conventional chord or conduit type downcomers are employed, no gaskets being necessary. The assembly is not sensitive to out-of-level installation, obviating the necessity for adjustable weirs. On a tray two weights of caps are normally used, the different weights alternating in rows parallel to the outlet weir and serving to ensure vapour distribution at low vapour rates irrespective of out-of-level installation. The lighter caps open during the first 20 to 30 per cent of tray capacity and the heavier caps from this range to 50 to 70 per cent of capacity. At higher rates all caps are fully open and thrust against their hold-down "spiders." It is stated that with these trays operation may be compared to a sieve plate except that the highest vapour velocity issues from the slot in a horizontal direction to overcome a sieve tray's tendency to blow dry or cone, in certain ranges. When all caps are open the "Flexitray's" contacting pattern simulates a bell-cap tray except that the lack of hydraulic gradient causes the vapour to flow at more uniform rates through all sections of the deck, materially reducing localised entrainment.

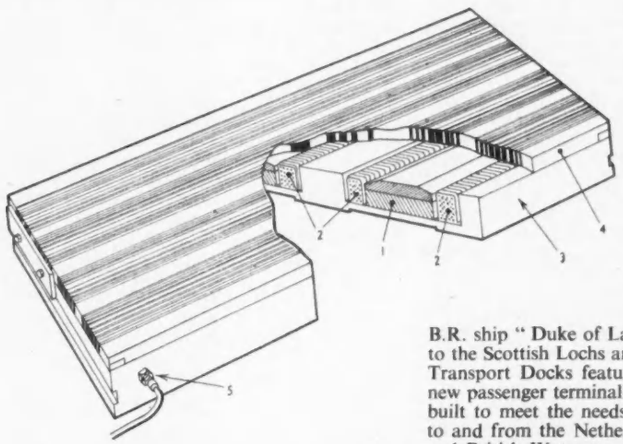
Main production bays in the new factory of Archibald Low and Sons, Ltd.

* Enter No. E4001 on Reply Card.

"Permanent-Electro" Magnetic Chucks*

THE "permanent-electro" or P.E. chucks developed by James Neill and Co. (Sheffield), Ltd., Sheffield, 11, are designed to combine the attributes of both permanent magnet and electro-magnetic chucks.

The general construction of the P.E. chuck is shown in the accompanying cut-away drawing.



(1) Alcomax magnets, arranged in parallel, below soft steel pole pieces.

(2) Magnetising and demagnetising copper coils, set in waterproofing jelly.

(3) Case of fabricated high permeability mild steel, ensuring rigidity and reliability.

(4) Top plate of laminated construction, providing longitudinal poles and magnetic gaps, with graduated reluctances.

(5) Copper-sheathed leads, ensuring complete protection against ingress of moisture.

The permanent-electro-magnet chuck has d.c. windings for magnetising and demagnetising and is made in four widths, ranging from 12in to 20in and four lengths ranging from 24in to 40in

Each of the permanent magnets 1 is associated with a suitable magnetising coil which can carry rectified current (d.c.) in either direction. Thus the magnets can be magnetised to saturation *in situ* and can easily be demagnetised to allow the workpiece to be removed from the work-holding surface, 4. Magnetisation and demagnetisation are effected by push-button control. As the current flows only during the process of magnetisation or demagnetisation heating presents no difficulties; the pull for holding the work is provided by the permanent magnets and, once applied, is independent of the power supply. The idea is that the magnet is operating at its full value of permanent magnetism at the instant when the circuit is broken and in this condition the pull of any permanent magnet is enhanced.

The work holding surface, i.e. the top plate, is of special construction. It is laminated with non-magnetic spacers of different thicknesses, as illustrated, so that the reluctances of the gaps are graduated. With this construction there is a more even flux distribution over the width of the pole. The relatively narrow pitch of the induced poles in the top plate improves the ability to hold thin materials. By keeping the total reluctance of all the gaps comparatively high the P.E. chuck is better able to hold rough parts or parts in which magnetic flux is difficult to induce.

Referring to the illustration it will be noted that the coils are set in waterproofing jelly, that the case, 3, is of high-permeability mild steel and that the power leads, 5, are sheathed in copper.

The controller including the rectifier is normally in a sheet steel cubicle and is designed to make and break on the a.c. circuit.

P.E. chucks are rectangular, in the following sizes: widths, 300mm, 400mm, 450mm, 50mm (12in, 16in, 18in, 20in approximately); lengths 600mm, 750mm, 900mm, 1000mm (24in, 30in, 36in, 40in approximately).

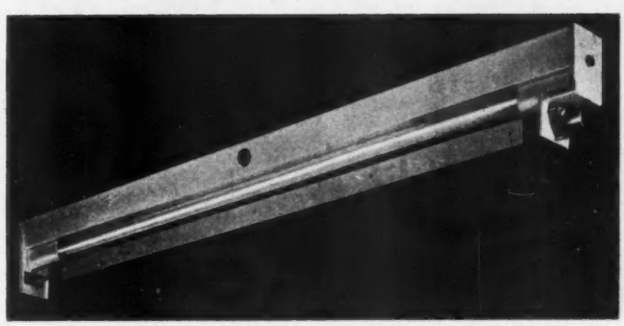
* Enter No. E4011 on Reply Card.

Tourist Award for B.T.C.

THE "Come to Britain" trophy, presented annually by the British Travel and Holidays Association for the most outstanding tourist enterprise of the year, has been awarded for 1959 to the British Transport Commission. It was received on behalf of the B.T.C. by Mr. J. H. Brebner, Public Relations Adviser to the commission, at the annual general meeting of the association on September 30. The improvements which earned the award were achieved in the activities of British Railways, British Transport Docks, and British Transport Waterways. On British Railways they were the Kent Coast electrification phase inaugurated on June 15, the "All-Line Railrover Ticket" on the railways and the B.R. Clyde and Loch Lomond steamers, and the nine-day Scottish Lochs Cruise by the B.R. ship "Duke of Lancaster" from Heysham to the Scottish Lochs and Western Isles. British Transport Docks features in the award for the new passenger terminal at Riverside Quay, Hull, built to meet the needs of passengers travelling to and from the Netherlands and Scandinavia; and British Waterways contributed the five-day "Heart of England" cruises between Nottingham and Boston in the new motor vessel "Water Wanderer."

Variable-Distribution Lighting†

ACTING on the idea that where work is carried out continuously by artificial lighting, the uniform intensity can create boredom and fatigue, Siemens Edison Swan, Ltd., 38–39, Upper Thames Street, London, E.C.4, is developing a system to provide periodic variations in the lighting pattern. The company's engineers are stated to have satisfied themselves that by slowly varying the intensity of light falling on the walls of a room, the static character of artificial lighting can be transformed into "a stimulating, glarefree, illumination." We illustrate one of the fluorescent fittings designed to produce this effect, which is achieved by an aluminium reflector mounted on bearings below or above the tube and rotated by a synchronous motor which turns the reflector through one revolution every hour. In the first 15 minutes the intensity of light-distribution below the tube increases gradually to the maximum value, and at the end of the next quarter-hour it has returned to the minimum level. The positioning of the reflector above the tube is adopted when fittings are mounted in a cornice for indirect illumination by reflection from a ceiling. Suggested applications of the technique are for offices, factories and schools. The present unit, known as the "Vitalite," accommodates one 5ft 80W fluorescent tube.

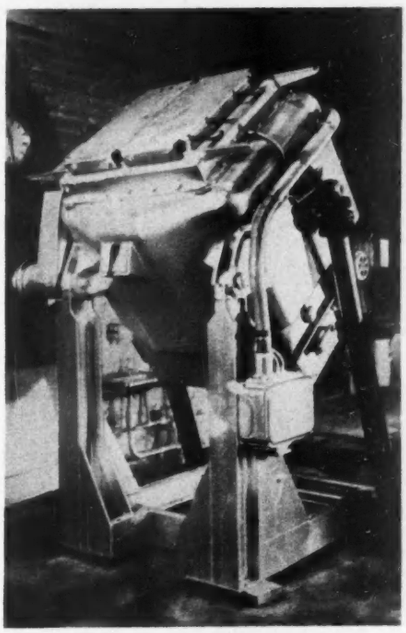


Fluorescent lighting fitting with motor-driven reflector below the tube

† Enter No. E4013 on Reply Card.

Mains-Frequency Induction Furnaces‡

WE have received from Fuller Electric, Ltd., Fulbourne Road, London, E.17, particulars of mains frequency induction furnaces constructed on the channel principle which have been developed recently by the ASEA group. Two of these are stationary designs, one being a single-chamber furnace intended mainly for holding molten metal, and the other a two-chamber furnace for the simultaneous melting and holding of aluminium, copper and their alloys. The tilting furnaces are intended both for melting and holding.



Melting furnace with tilting machinery

We illustrate the LFR25/125 furnace in the series, which has effective capacities of 460 kg of aluminium, 1450 kg of brass or 1540 kg of copper, and has an input rating of 125kW. In addition to these effective melting or holding charges, a sump charge of between 150 kg and 500 kg has to be retained in the channel to enable the furnace to continue functioning.

Tilting is by a hydraulic system comprising double telescopic cylinders and a self-contained pumping set. Continuous variation of tilting speed within wide limits is possible.

In all furnaces the furnace transformer comprises a butt-jointed core and a primary coil treated to withstand a continuous temperature of up to 400 deg. Cent. Fans are fitted for cooling channel blocks and primary coils. Provision is made for easy replacement either of the coils or, in the tilting furnaces, of complete inductor units comprising the furnace transformer and channel block with melting channel. Electrical equipment comprises cubicles with switchgear, meters and automatic temperature control circuits, and capacitor banks for power factor correction.

Special foundations are not required, and the furnaces can be placed direct on the floor. The supply voltages are 220V, 380V or 500V, 50 c/s, single-phase.

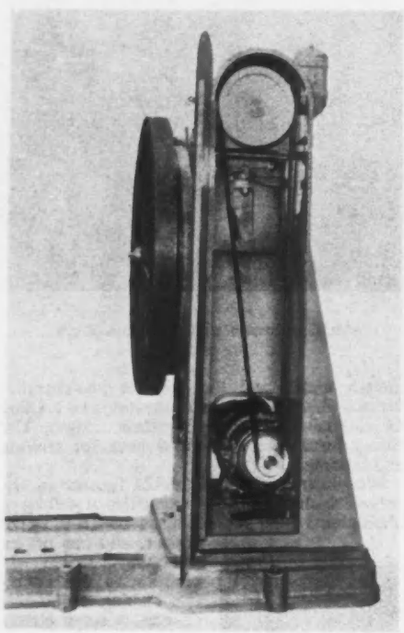
‡ Enter No. E4014 on Reply Card.

Eddy Current Speed Regulator*

PRODUCTION has begun by Westool, Ltd., St. Helen's Auckland, Co. Durham (and 2, Ashley Place, London, S.W.1) of an electromagnetic eddy current speed regulator known as the "Elcotron." This device is intended for use with constant-speed electric motor drives as a coupling, a clutch, and a torque limiter and controller. It comprises a stator with a stationary field coil in which rotates an annular rotor and a central rotor, the latter being driven by the prime mover, whilst the former is attached to the driven load. When there is no current flowing in the field winding, the input shaft and rotor run idle, while the annular rotor coupled to the output shaft remains stationary. When direct current is fed into the field winding a magnetic field is created which, being modulated by the teeth of the central input rotor, induces eddy currents in the annular rotor, causing the latter and the output shaft to rotate. The speed of the output shaft depends on the exciting current in the winding and on the torque to be supplied.

The "Elcotron" is convenient for remote control applications in that the wattage controlling the excitation is only a fraction of the horsepower that can be transmitted, e.g. 1kW can handle a transmitted power of 200 h.p. Speed can be manually or automatically controlled and infinite variability from zero to just below the speed of the driving motor is obtained when coupled to a squirrel-cage induction motor. Efficiency of the drive at full speed is stated to be 97 per cent. Excitation may be obtained from any convenient source of variable d.c., such as a transformer-rectifier set with adjustable rheostat. Feedback control may be applied through a magnetic amplifier, and both the output speed and torque can be held automatically constant at any level irrespective of load changes. Where it is required to drive one machine from two or more motors, an "Elcotron" regulator can be fitted to each motor and controlled so that the driving motors always supply equal power to the machine, avoiding undue stress on either motor. On conveyor systems, where a conveyor is powered by two or more motors, each motor can be equipped with a regulator and automatically synchronised to give constant conveyor speed throughout the system. Other applications include coil-winding machines (as illustrated), printing machine drives where inching speeds are required for setting up, and winch drives.

The "Elcotron" is based on a French design of coupling which has been used for powers up to 1000 h.p. Westool, Ltd., is at present manufacturing the device for drives from 0·25 h.p. to 250 h.p. and is supplying it in Commonwealth countries.



Faceplate coil winding machine with belt drive from eddy current coupling (in base) for maintaining constant linear speed and tension in wire

* Enter No. E4021 on Reply Card.

Ground-to-Air Radio Transmitter†

A NEW 1kW v.h.f. transmitter with characteristics particularly suited to long-range aircraft control r/t communications at airports has been developed by Pye Telecommunications, Ltd., Cambridge. It can also be applied to teleprinter working and point-to-point voice-frequency links.

As seen in the illustration, it consists of two self-contained units (the r.f. and modulator sections) which may be combined as a single equipment for telephony. The r.f. unit houses the crystal oscillator, three multiplier stages providing a total multiplication of twelve times the crystal frequency, two push-pull intermediate amplifier stages and a push-pull final amplifier, together with power supplies and the control system for the whole transmitter. Forced air cooling is provided for the output valves. Frequency range is 118 to 136 Mc/s and the transmitter is set up to work on a single channel in this band. A change of channel frequency can be effected in a few minutes. Normal frequency stability is 0·004 per cent over the temperature range −10 deg. to +55 deg. Cent., but a temperature-controlled crystal oven is available if still higher stability is required.

Radio-frequency (left) and modulator units (right) of 1kW v.h.f. transmitter assembled in cabinet measuring 3ft 9¾in wide, 2ft 6½in deep and 7ft 3in high

The modulator section will provide 100 per cent amplitude modulation of the transmitter output with speech or a sinusoidal tone and is stated to have less than 10 per cent total harmonic distortion at 90 per cent modulation depth. Cooling air for the whole equipment is drawn through dust filters in the two rear doors and discharged by a fan in the top of the cabinet. All valves can be replaced from the front of the transmitter. A recycling arrangement restores transmission after transient faults but shuts down the transmitter if a fault persists after three successive restoration attempts.

† Enter No. E4022 on Reply Card.

Solenoid Valves and Pneumatic‡ Cylinders

AN improved design of the "Pneulang" solenoid valve has been introduced by Lang Pneumatic, Ltd., Owen Road, Wolverhampton.

The range of application of these valves has been extended by a redesigned solenoid unit which is readily interchangeable on a number of valve assemblies, varying from ¼in B.S.P. two-way valves to 1in B.S.P. four-way valves and 1½in B.S.P. three-way valves. In this solenoid any voltage coil, either a.c. or d.c., can be readily interchanged.

The iron circuit of the solenoid consists of the circular coil housing and a top and bottom plate, all of which are fully annealed and cadmium plated to resist corrosion. The coil, which is continuously rated and fully tropically impregnated, is supplied in a number of standard voltage bands and can accommodate a variation of 5 per cent in voltage above or below the stated band. The armature guide sleeve of a self-lubricating plastic material is practically impervious to water absorption and stated to be very stable over a wide temperature range. The armature and the top spigot are made from a stainless iron alloy, treated to give the correct magnetic properties.

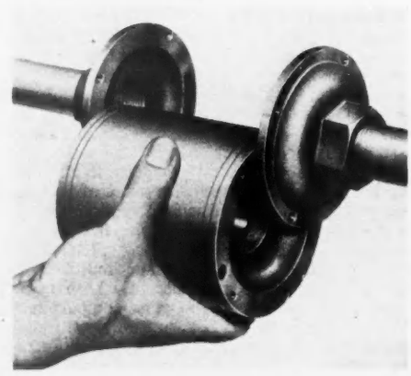
In the new equipment range of the firm there are three types of pneumatic cylinders, the first of which is a 1½in bore double-acting, 4in stroke, double-foot-mounted cylinder, with cushioning both ends and having the rod through both ends. There is also a 1½in bore double-acting, flange-mounted cylinder with a stroke of §in, and a 2½in bore double-acting, double-foot-mounted cylinder with a stroke of 9¾in. Each of these cylinders is arranged for double solenoid operation by integrally mounted solenoid valves of the improved design.

‡ Enter No. E4023 on Reply Card.

Small Hot Water Accelerator§

AN accelerator for small central hot water heating systems known as the "Daxel" now being made by Rhodes, Brydon and Youatt, Ltd., Gorsey Mount Street, Stockport, is rated at 2 to 8 g.p.m. against 8ft to 1½ft head, and is suitable for static pressures up to 25 lb per square inch and water temperatures up to 180 deg. Fah. The standard units have a 1in B.S.T.P. branch but are adaptable for other pipe sizes, and they can be fitted at any angle in the pipe system.

The meter fitted in the accelerator has a consumption of about 80W, and before the water passes through the motor shaft into a radial impeller an integral filter removes any grit or dirt likely to harm the moving parts. The motor stator is free to oscillate about its own axis and any vibration is absorbed by torsional oscillation which contributes to silence in operation of the unit. Self-lubricating bearings eliminate need for any particular care or maintenance whilst an accelerator is in service.



Hot water accelerator with main pump body being removed from the pipework

As can be seen from the accompanying illustration, both ends of the unit are screwed directly into a pipe system, and, if necessary, the central pump portion can readily be removed for inspection without disturbing the pipework. The complete unit weighs only 15½ lb.

§ Enter No. E4024 on Reply Card.

Pump and Crane Factory at East Kilbride

A NEW factory has been opened by J. H. Carruthers and Co., Ltd., at East Kilbride, Glasgow, for the manufacture of pumps and cranes. This firm was established over seventy years ago at Polmadie, Glasgow, for the manufacture of marine pumps, separators, filters and condensers, and it began making cranes during the last war in a new division situated at Lambhill and Parkhead. In the new factory one of the two bays is laid out for the manufacture of the firm's wide range of centrifugal and reciprocating pumps, condensers, separators and filters; and the other bay for the manufacture of industrial electric overhead travelling cranes, steelworks cranes and "Goliath" cranes. The pump division bay is illustrated on this page. The bays are portal framed structures designed to carry 25-ton overhead cranes having a span of 70ft. The upper walling on the north, east and south walls is Robertson "Q" panelling, asbestos sheeting being used for the west wall where the structure is designed for future extension. The lower part of the wall for 11ft from the floor level is of cavity brick. The complete factory has been designed to comply with the latest legislation for thermal insulation; and where there is "Q" panelling and asbestos sheeting this insulation is obtained by a fibre glass in-fill.

There are large roof and side wall windows, which, assisted by the colour scheme inside the factory, afford a high level of natural illumination. Artificial lighting is provided by high bay colour-correct mercury vapour fittings giving an illumination of 17ft candles at working level.

Heating for the factory and offices is supplied from three electrode hot water boilers producing 7,400,000 B.Th.U. per hour under a fully automatic system which operates on an off-peak tariff. The hot water is pumped through radiant panels in the factory and the head in the system of 50 lb per square inch is maintained at a predetermined value by a nitrogen pressure generating unit. The office heating operates on a low-pressure pumped system fed via a calorifier from the factory system. The power-operated doors at the north and south ends of each bay are fitted with automatic heat curtains which operate whenever the doors open and remain on until the doors are fully closed.

A test bed has been installed in the pump division to handle pumps with outputs of up to 2000 tons of water per hour. For this purpose steam is produced by an electrode boiler operating on an off-peak tariff in conjunction with a steam accumulator. Full steam pressure can be obtained within five minutes of switching on the boiler and the steam output can be controlled by suitable setting of the boiler controls. Both a.c. and d.c. power is available on the test bed for motor-driven pumps. The water measuring equipment has been carefully designed to ensure that maximum accuracy in the readings is obtained and in every case British Standard recommendations have been used.

All the services in the factory are electrical, no coal or oil being used, and the total input is 4000kW. Power is mainly distributed by a busbar system on each outer wall and between bays. In addition to this supply small underfloor ducts have been introduced below the machines to facilitate movement and reconnection should plant re-arrangement be necessary at some future date.

Bay equipped for the manufacture and testing of pumps

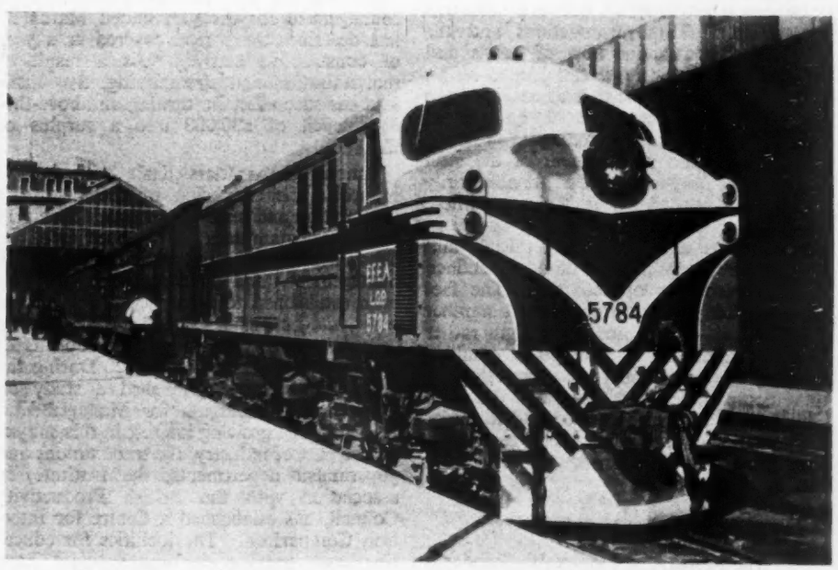
British Diesel Locomotives in Argentina*

ECONOMIC factors have limited the extent to which British manufacturers have been able to participate in the diesel locomotive programme of the Argentine railways, but orders placed in 1956–57 included one for twenty-one units of 1000 h.p. from The English Electric Company, Ltd.

All the twenty-one English Electric locomotives have now been shipped to Argentina. Power and transmission components were built at the English Electric works at Preston, and mechanical parts at the Vulcan Foundry, Ltd., and Robert Stephenson and Hawthorns, Ltd. The locomotive is for the metre gauge and is carried on two three-axle swing bolster bogies with their outer axles motored. It is powered by an English Electric "8SRKT" engine which has been derated from 1000 h.p. to 940 b.h.p. at 850 r.p.m. to meet the conditions of high temperature and humidity in which the locomotives work. Weight of the locomotive in working order is 73 tons. Starting tractive effort (30 per cent adhesion) is 35,000 lb and the continuous tractive effort rating is 22,710 lb at 11·5 m.p.h. There are two steps of traction motor field diversion, giving a top speed of 50 m.p.h. at which the tractive effort is 5000 lb. The nose-suspended traction motors are six-pole, forced-ventilated machines connected in parallel groups of two motors in series. A six-pole, single-bearing main generator and overhung auxiliary 110V generator form one flexibly-mounted unit with the diesel engine. An automatic load regulator controls the main generator excitation and initiates field-weakening of the traction motors when appropriate. The radiator fan is mechanically driven from the engine crankshaft through a gearbox and centrifugal clutch, and a drive is also taken from the gearbox to the compressor.

Two driving positions, one for each direction of travel, are provided in the cab, which extends the full width of the locomotive. The power control handle provides continuous adjustment of diesel engine speed, and on its initial movement from "off" causes the reverser to be thrown to "forward" or "reverse," as pre-selected by the master switch, as well as closing the motor contactors. The locomotives are being used on suburban passenger trains and fast goods trains. In goods service two units are coupled to handle loads of 1600 tons. Three locomotives may be operated in multiple if required.

* Enter No. E4031 on Reply Card



Metre-gauge, 1000 h.p. diesel-electric locomotive at Retiro station, Buenos Aires

Industrial and Labour Notes

Britain's Steel Industry

A lucid exposition of the British steel industry is included in the latest number of *Steel Review*, which is published by the British Iron and Steel Federation. The steel industry, it says, is often thought of as a separate, self-contained sector of the economy, consisting of a few large works in which are performed a few, relatively simple, large-scale operations. In fact, steel melting, rolling and forging cover a complexity of activities carried on by over 300 companies of different sizes and kinds of output. The industry itself distinguishes thirty-five groups of products and within those groups are products of all shapes, sizes, composition and kinds of finish. The processes are extremely varied and elaborate. An inquiry was made recently among 159 privately-owned companies to discover the range of their activities outside the field of iron and steel. These companies employ about 227,000 people on iron and steel production, or an equivalent of 82 per cent of the total employment covered by the British Iron and Steel Federation.

Most companies in the industry have evolved over a long period, adapting themselves to changes in markets and sources of supply and in production and management techniques. Each of these steel companies, the *Review* comments, has a life and vitality of its own, conditioned by past influences and future purposes. Each can usefully be helped by co-operative action within the industry, but each would find its efficiency seriously impaired by rigid external direction. It is not often realised, the *Review* goes on to say, how many individual transactions go into manufacturing and selling steel and associated products. On average, each company has over 2000 customers, including 170 or so overseas. Thirteen of the companies examined had over 5000 customers each, and two of these had over 10,000 customers. The estimated number of deliveries made by the industry as a whole in 1957 was 4,500,000, including over 200,000 to destinations overseas. Eleven of the companies covered by the inquiry recorded over 100,000 outward consignments each. These transactions and the varied and continuous flow of goods and services which they represent depend on an intricate web of personal relationships built up over many years, based on mutual confidence and underststanding.

Ownership and management of the steel industry, the *Review* concludes, are necessarily and rightly carried on in terms of whole companies. On the other hand, co-operative activities and public supervision and control are organised within a defined range of products or activities. The fact that these activities are common to a number of companies is a source of strength rather than weakness. Any attempt to combine centrally the direction and ownership of these companies would go against the grain of industrial organisation and lead to major inefficiencies. It would also necessarily undermine the companies' goodwill and trading achievements.

Commonwealth Standards

The fourth Commonwealth Standards Conference was held recently in Ottawa. It was attended by about seventy delegates representing industrial concerns and standards organisations in the United Kingdom, Australia, Canada, India, New Zealand, Pakistan and South Africa. Reports of the conference indicate that useful progress was made towards the greater alignment of the industrial standards of those countries.

There were three technical sessions on steel, air receivers and cranes, all subjects of importance in intra-Commonwealth trade. At the steel session, there was presented a review of the progress made since the 1957 conference in implementing recommendations about standards for cold formed light gauge sections and their use in building structures, high strength friction grip bolts, and the use of steel in general building construction and in bridges. Reference was also made to the important developments taking place in all parts of the world in steel production techniques. In this context, the need for re-designing hot rolled sections in order to make more efficient use of steel was discussed. But it was felt that it would be premature to decide what the new designs should be until future steel mill practice became clearer. Another matter which was considered was the desirability of co-ordinating specifications for wrought carbon and alloy steels, though no clear pattern emerged as to the basis on which that might be done.

In a general session of the conference, views were exchanged on the problems of certification marking and approval schemes in regard to administration, control of quality and publicity to promote acceptance of these marks as well as understanding of the independent assurance which they carry. There was also an exchange of views about the problems of inch and metric measures. In particular, the conference discussed procedures to reduce the inconvenience caused by the existence of the two systems and to achieve the maximum interchangeability of goods through the adoption of corresponding inch and metric sizes and standards.

British Institute of Management

The report of the British Institute of Management for the year ended March 31 last describes the period covered as a year of constructive activity. As a result of reorganisation and streamlining, the Institute has succeeded in turning an above-the-line deficit of £30,000 into a surplus of £20,000.

Among the matters dealt with in the report is the expansion of the Institute's information and research services. Specialist advisory committees have been set up, consisting of experts in particular aspects of management, and a committee has also been established to advise upon services to top managements who may not be directly concerned with the day-to-day problems of any one management function. During the year, the Institute published a study on "Interfirm Comparison for Management." As a result of growing interest in this subject on the part of industry, the trade unions and government departments, the Institute, in association with the British Productivity Council, has established a Centre for Interfirm Comparison. The facilities for education and training for management have continued to develop. The report says that the number of technical colleges operating the national scheme of management studies increased last year to 104, compared with eighty in 1956.

N.U.R. Plan for Transport

The National Union of Railwaymen has published a "policy statement on transport." The proposals made in it include : co-ordination of the major forms of transport ; modernisation that does not include contraction based on short-sighted economies but which would allow increased railway facilities and provision for the bulk of long-distance freight to go by rail ; guarantees for workers who become victims of technical change and the full use of railway workshops, even for work outside the industry.

The statement says that transport integration presupposes the development, modernisation and rationalisation of the railway system. Without a modern railway system, it is added, a scheme of co-ordination and integration will not achieve balance and economy with other forms of transport. But, the statement continues, the organisers of transport should recognise that this is not a static conception. Having a modern railway system implies development and change in equipment, techniques and operation. This, the N.U.R. says, will have to be continuous if the full benefits of technology are to be gained. It must also be continuous because railway transport facilities must move "as closely parallel as possible with variable flows and volumes of traffic." The N.U.R. plan urges that this must be considered within "the whole flexible inner operation of the overall framework of road-rail-inland waterways integration of transport facilities."

Rural Industries

The annual report of the Rural Industries Bureau, which has just been issued, gives as always an interesting account of the many and varied industries established in all parts of rural Britain. In a foreword to the report, Sir Basil Mayhew, chairman of the Bureau's trustees, says that a "rural industry" has never been positively defined for the simple reason that there are so many factors which could and should influence the adoption of the title. It might surprise some, Sir Basil adds, that amongst the small producers whom the Bureau has assisted are manufacturers of dentists' chairs, glass fibre kitchen sinks, scientific instruments, television aerials, surgical appliances for spastics and lithographic printing machines.

The chapter of the report surveying the activities of the Bureau's engineering section says that the section's work falls broadly into two parts, namely, technical advice and instruction. During the year covered by the report, the Bureau was again called upon to give technical advice on the choice of plant and equipment, the suitability of techniques for various purposes, machine and component design, sources of supply of materials, and the survey of sites and preparation of designs for new buildings. In general, the report observes, demands on the section increased last year and are now very heavy indeed.

Space Research

No. I

By R. FELLOWS,* J. E. JACKSON,* H. E. NEWELL, Jr.,* and M. STOLLER*

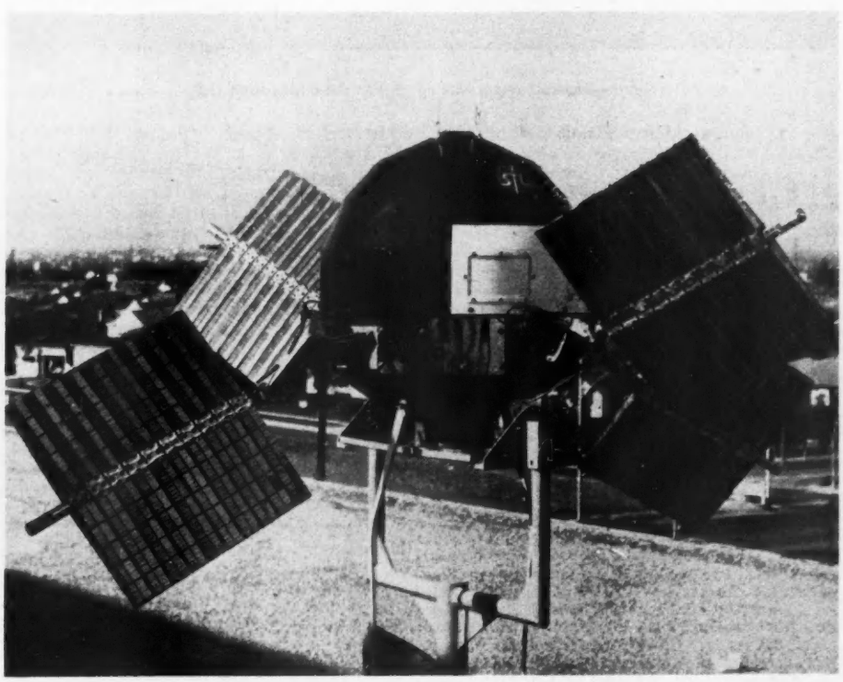
At the ninth general assembly of A.G.A.R.D., the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organisation, held at Aachen on September 24–25, there took place a round-table discussion on "Space Research Techniques and Recent Experimental Data." A survey paper on the subject was prepared by N.A.S.A. and is reproduced almost completely here. Experts from different N.A.T.O. nations were then invited to contribute information on their own activities, results and future research.

PAST RESULTS OF SPACE RESEARCH

BY liberating scientific disciplines from their earth-bound limitations, space research has resolved many long-standing problems and controversies. The rate of progress was accelerated in many scientific areas and in some cases completely new fields were unveiled.

For convenience, we shall divide the subject into several broad areas: Atmosphere, Ionosphere, Energetic Particles, Electric and Magnetic Fields, Gravitational Fields, Astronomy and Bio-sciences. Actually the various areas are related in many complex ways, and the investigation of the various inter-relationships is very important in itself. A brief discussion of each of the above areas is presented ahead of the results obtained from space research, in order to place these results in their proper perspective.

* National Aeronautics and Space Administration, Washington 25, D.C.



"Explorer VI" is shown with its four solar cell paddles extended before launching at Cape Canaveral, Florida. Until the orbital height was reached, the paddles were folded beneath the satellite as seen in the heading illustration, where the fairings are being fitted to the "Thor-Able" vehicle. The honeycomb core of the paddles can be discerned. The 142 lb payload bears the insignia of Space Technology Laboratories

Atmosphere

The existence of atmospheric pressure was unknown until Torricelli's invention of the mercury barometer in 1643. Perhaps equally important was the creation of the first vacuum chamber in the space above the mercury column. The rapid improvement of vacuum techniques during subsequent years was evidenced by the spectacular demonstrations performed in 1654 with the Magdeburg hemispheres. But far more significant was the availability of a new and essential tool, namely the vacuum chamber, with which the physics of gases could be studied. By the end of the seventeenth century the basic laws governing the distribution of pressure with altitude had been derived by Mariotte and Huygens. However, assumptions regarding mean molecular mass and temperature introduced considerable uncertainties in the numerical results, which were derived from the basic gas laws. Prior to the availability of rockets for upper atmosphere research, the atmospheric structure was accurately known up to about 30km, as a result of balloon investigations. Although crude estimates regarding the structure of the upper atmosphere were available from meteor, ionospheric, and auroral studies, the atmosphere above 30km was relatively unknown until 1946, when rocket soundings were initiated. As will be shown later, rocket research has considerably increased our knowledge of the upper atmosphere. Nevertheless, many questions still remain unanswered concerning the origin, evolution, nature, spatial distribution, and dynamic behaviour of the upper atmosphere; its relation to interplanetary space; its sources of energy; its relationship to surface meteorology; and its influence upon instrumented or manned space flight. Of interest from a longer range viewpoint are the analogous problems which are presented by the atmospheres of the other planets.

Rocket Results.—Rocket measurements have provided a fairly complete and accurate picture of the atmosphere up to about 110km. Results have also been obtained between 100km and 200km. The temperature distribution with height exhibits a maximum of about 270 deg. K. at 50km, a minimum of about 200 deg. K. around 80km, a sharp rise in the E-region, leading to values of the order of 1500 deg. K. at 200km. Up to about 70 miles (110km) altitude, density

and pressure both fall off by roughly a factor of 10 for every 10-mile (16km) increase. Densities measured at 200km above White Sands, and above Fort Churchill, Canada, were found to vary by a factor of 5. Diurnal and seasonal effects were also detected at altitudes between 50km and 200km. Rocket measurements show that the atmosphere is well mixed and maintains ground level composition up to 100km, with the exception of lesser constituents such as water vapour and ozone. Above 100km, diffusive separation takes place, with the lighter elements becoming more abundant. In addition, photo-chemical dissociation produces atomic oxygen and nitrogen. By 1952, enough rocket results had accumulated to compile the available information into a standard atmosphere, which was quite reliable up to 80km. The results obtained, during the International Geophysical Year will permit the formulation of a meaningful standard atmosphere up to at least 200km and perhaps up to 500km.

Satellite Results.—Satellite drag measurements were made at altitudes between 180km and 725km. The densities obtained for the lower altitudes are in general agreement with rocket results, when seasonal and latitude variations are considered. Taken together the satellite and rocket measurements show considerable variation in upper atmosphere densities and temperatures with time of day and geographic position. This appears to be particularly true for altitudes above 220km.

Ionosphere

The growth of radio and electronics at the beginning of the twentieth century led inevitably to the discovery of the earth's ionosphere. This ionised region of the upper atmosphere has been investigated extensively from the ground on a world-wide basis by a method which is an extension of the experiments originally performed by Breit and Tuve in 1926. The method, which is similar to radar, is based upon the reflection of radio waves by the ionised regions. Ionospheric electron densities can be computed from these soundings; however, the height distribution of these densities was in some cases uncertain by as much as 100km. This uncertainty arose partly from the extreme complexity of the analysis required, but mainly from the assumptions needed to interpret the discontinuities found in the ground recordings. Even though early observers knew that their data should be interpreted with caution, they felt fairly well convinced that the ionisation was concentrated in separate layers which they called "D," "E" and "F." Considerable information was nevertheless accumulated which revealed the general behaviour of the ionosphere below 300km, particularly its daily and geographical variations, and the influence of the eleven-year solar cycle.

Rocket determination of typical electron density profiles, plus the recent availability of electronic computers, have resulted in a greatly enhanced activity in the world-wide analysis of ground recordings. Fairly accurate electron density profiles can now be obtained up to the maximum of the "F_2" region which occurs at approximately 300km in middle latitudes. Typical daytime densities are 10^5 el/cc. in the "E"-region and 10^6 el/cc. in the "F"-region. Faraday rotation measurements made by reflecting radar echoes from the moon have shown that the total ionisation content above "F_2" maximum is in the daytime about three times greater than the columnar electron density from the ground up to "F_2" maximum. At night this three to one ratio is increased to about four to one. Whistler data give approximate densities between 100 el/cc. and 1000 el/cc. at several earth radii. Ionosphere problems exist in three broad areas, namely: (1) the accurate determination of the spatial and temporal variation of the ionospheric structure; (2) the explanation of the mechanisms responsible for the ionisation; and (3) the propagation of radio waves in the ionosphere. A natural extension of this work will be the study of the other planetary ionospheres, including that of the moon.

Rocket Results.—Electron density profiles for the 80km to 250km altitude range are available from at least ten and perhaps as many as twenty rocket flights. A few measurements were made at altitudes between 250km and 500km by both Russian and U.S. scientists. These measurements show that the daytime ionosphere does not consist of separate layers; it was found instead that the regions of relative maximum ionisation blend gradually together with only minor valleys in the ionisation distribution versus height. Superimposed upon this continuum are occasional very high ionisation gradients. Studies of rocket-to-ground radio propagation reveal considerable fluctuations in the received signals which are probably due to multi-path transmissions resulting from inhomogeneity in the ionospheric structure. The absorption of radio waves has been accurately measured in the "D"-region and the collision frequencies calculated therefrom were shown to be at least three times smaller than was generally believed to be the case. The polar blackout was shown to be strictly a "D"-region phenomenon with no significant effects noted above 100km. Two night flights conducted near the winter solstice showed that electron densities in excess of 10^6 el/cc. were present in auroras, whereas densities of only 10^4 were present in the absence of auroral activity. Mass spectrometer studies in the ionosphere reveal that the most important positive ions are those of nitric oxide, molecular oxygen, and atomic oxygen. Above Fort Churchill it was found that as the altitude increases from 100km to 150km to 200km the order of relative abundance of positive ions during the daytime changes from (O_2^+, NO^+) to (NO^+, O_2^+, O^+) to (O^+, NO^+, O_2^+); but at night the NO^+ is more prevalent at the lower altitudes.

Satellite Results.—Although highly publicised, the satellite measurements of electron densities have to date been relatively crude. They were based primarily upon propagation studies and required the assumptions of uniform horizontal structure and single ray paths, both of which are known to be incorrect. Severe fluctuations in signals received from satellites, particularly from above "F_2" maximum, are evidence of horizontal gradients and globular irregularities. Mass spectrometer data obtained from "Sputnik III" show that in the region from 250km to 950km, the principal positive ion is mass 16, O^+, with a small percentage of mass 14, N^+.

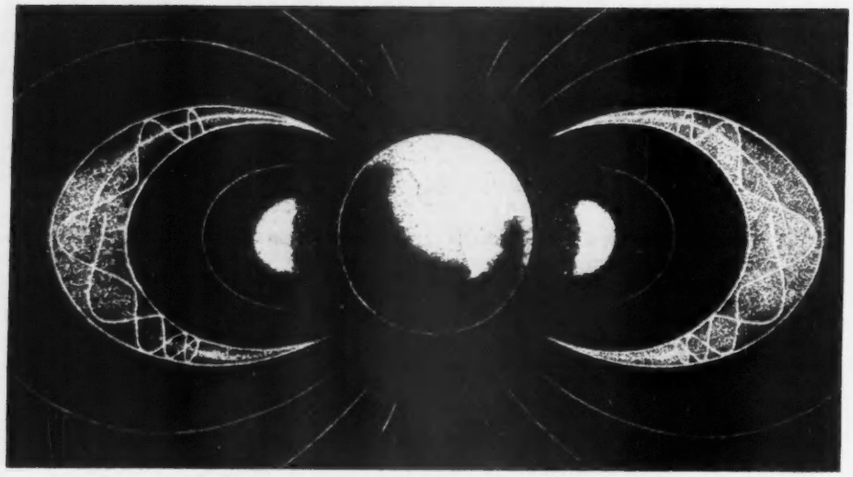


Fig. 1—Pictorial representation of Van Allen Radiation Belts

Energetic Particles

Early in the century it was discovered that an electroscope very slowly loses its charge no matter what precautions are taken to insulate it. It was at first assumed that this was caused either by leakage around the insulation or by radiation from radioactive materials in the earth's crust. A series of balloon flights conducted during the period 1911 to 1914 established that the discharge of the electroscope was due to a radiation of extra-terrestrial origin. These observations may be regarded as constituting the discovery of cosmic rays. The fascinating problems presented by this new field led Karl Darrow to state: "The subject is unique in modern physics for the minuteness of the phenomena, the delicacy of the observations, the adventurous excursions of the observers, the subtlety of the analysis and the grandeur of the inferences." Following World War II, intensive studies with balloons resolved many of the questions associated with cosmic rays. These studies revealed that the primary cosmic radiation consists of protons, alpha particles and heavy nuclei. The energy spectrum in the 1 Bev to 15 Bev range was determined by measurements at various geomagnetic latitudes, since in this energy range the penetration of cosmic rays is controlled by the orientation of the terrestrial magnetic field. Other techniques such as the observations of giant showers over areas of several acres show that the energy of cosmic rays can be as great as 10^9 Bev. Another group of particles with energies ranging from 10^3 to 10^6 electron volts was postulated in order to explain auroral phenomena. These particles were believed to be either protons or electrons. Altnough the absence of particles with energies between 1 Mev and 1 Bev was a principal enigma, many problems also existed in connection with the observable particles in the lower and higher portion of the energy spectrum. Typical questions were: the origin of the particles, the mechanism by which they acquire their energies, their effects on both animate and inanimate objects, and their detailed composition including the possible presence of anti-matter.

Rocket Results.—Rocket work showed primarily that balloon measurements were adequate for many cosmic ray studies. It was established that the knee in the latitude curve was real and not due to air absorption cut-off. Rocket measurements of auroral particles showed that both protons and electrons are present in auroras; however, the auroras investigated to date with rockets were produced mainly by electrons with a few kilovolts of energy.

Satellite and Probe Results.—Auroral electrons were detected by Soviet scientists in an experiment carried aboard "Sputnik III." Within the auroral zone, in the energy range of 200 to 300 Kev, a flux of 10^4 particles per square centimetre per second was deduced as typical; while in the range 20 to 60 Kev a typical flux was 10^7 particles per square centimetre per second. U.S. satellites and space probes established the unexpected existence of the Van Allen Radiation Belt and partially mapped the region of space which it occupies. This belt appears to be composed of charged particles trapped in the magnetic field of the earth, and with energy levels ranging from those encountered in auroras up to those of cosmic rays. Measurements to date indicate that a portion of the more penetrating radiation in the inner region of the belt consists of protons. One explanation is that these protons are decay-products of fast neutrons of the earth's cosmic ray albedo. The remainder of the Van Allen Belt is probably of solar origin. Results from the Soviet satellite experiments appear to be consistent with those of Van Allen. The Soviet deep space probe "Mechta" has shown that a portion of the radiation in the outer region of the Van Allen Belt is composed of electrons with energies of a few tens of Kev (Fig. 1).

Electric and Magnetic Fields

1. *Electric Field.*

The manifestations of atmospheric electricity as revealed by lightning and thunder have for thousands of years inspired more fear than scientific curiosity. In 1752 the electrical nature of lightning was demon-

strated by Franklin in his celebrated kite experiment. In that same year Lemonnier observed the less well-known and much less intense atmospheric electric field during fair weather. Investigations from the ground, balloons and aircraft have shown that the earth's atmosphere can be considered as a leaky condenser of 200-ohm resistance through which flows about 1500A of current. It is believed that the necessary upper atmospheric potential of about 300kV relative to the earth's surface is maintained by world-wide thunderstorm activity. Evidence of electrical storms on Jupiter indicates that similar phenomena exist on the planets.

Due to the high conductivity of the medium, it is unlikely that strong electric fields can be maintained within the ionosphere. Electric fields which might be postulated above the ionosphere are probably too small to be measured with present techniques. It is known, however, that a conducting body will acquire a charge in an ionised medium due to the high ratio of electron-to-ion mobility. This charge will produce near the surface of the body an electric field which was not present in the ambient medium. This local contamination of the medium must be taken into consideration when interpreting data obtained from an experiment in which a direct sampling of the medium is attempted. Charge on space vehicles could conceivably introduce appreciable electromechanical drag, particularly in the Van Allen Radiation Belt, and hence influence space flight.

Rocket Results.—Electric fields of the order of 500V/metre were measured at the surface of a U.S. rocket, in the presence of a strong r.f. field produced by an antenna radiating a 4 Mc signal from the rocket. Since this field was about twenty times greater than expected from kinetic theory, it is believed that this enhancement was caused by the presence of the r.f. field. The field distribution was also found to be affected considerably by photo-emission from the sun.

2. *Magnetic Field.*

Although magnetisation was a phenomenon known to the ancient Greeks, it was considered chiefly as an amusing curiosity until the Chinese discovery of the magnetic compass during the Middle Ages revealed what turned out to be the most important application of magnetism for centuries to follow. The magnetic compass has been used by navigators since the eleventh century, but it was not until 1600 that Gilbert pointed out that the earth itself behaves as a giant magnet. During the past century magnetic observatories and surveys have provided rough maps of the magnetic field at the surface of the earth. The strength and orientation of the main field are subject to a slow secular drift. Geological differences introduce surface irregularities called anomalies. At a given location sensitive instruments reveal regular diurnal variations with superimposed irregularities, such as magnetic disturbances and storms. It is believed that these variations are caused primarily by electric currents in and above the ionosphere. However, due to the limitations of ground observations, definitive answers must await direct measurements from space vehicles. Although the magnetic field decreases in intensity according to the inverse cube of the distance to the centre of the earth, its effect upon the atmosphere above 100km increases rapidly with altitude. At much greater heights, where charged particles predominate, the earth's atmosphere is controlled by the magnetic field rather than by hydrostatic conditions. The problems associated with the magnetic field cover a far greater scope than indicated above. They range from basic questions concerning the very existence of the terrestrial field and its possible relationship to the initial formation of the earth, to speculation concerning the values of interplanetary and interstellar fields and the manner in which these affect cosmic rays and auroral particles.

Rocket Results.—Measurements into and through the "E"-region, at the magnetic equator and the auroral zones, have demonstrated the existence of electric currents in the lower ionosphere. These currents were found to be far more irregular than anticipated. The need for absolute magnetometers in space research has greatly stimulated the development of new types of magnetometers which have found great practical use on the earth's surface in military and civilian applications.

Gravitational Fields

Although the names of Newton and Einstein are usually associated with gravitation, this field has attracted the interest of, and received contributions from, a galaxy of scientific geniuses, including Galileo, Huygens, Euler, Bernouilli, Laplace, Lagrange, d'Alembert, and Hamilton. At the present time, the best theory concerning the nature of gravitation is Einstein's general theory of relativity, which asserts that gravity results from a distortion of space-time. This theory is, however, still far from being entirely satisfactory. For example, one does not know whether or not there is a "velocity of propagation" associated with gravitation; the relationship, if any, between the theory of the electromagnetic field and the gravitational field has not yet been discovered. Controlled experiments on an astronomical scale are required to test adequately the theory of relativity and to detect some peculiarity of the law which may lead to a more fundamental understanding.

A large group of problems falls within the framework of the Newtonian Law, such as the long-time stability of the solar system the gravitational fields of the planets, the gravitational field of the earth, and the manner in which these fields affect space trajectories or reveal the internal constitution of the planets.

Rocket Results.—In a broad sense, each rocket flight provides a new verification of Newton's laws. Rocket experiments, however, are too short to detect gravity anomalies or to contribute to our knowledge or relativity.

Satellite Results.—The periods of artificial satellites are so much shorter than those of the moon and planets that we can observe in a few months effects which may require centuries to detect from the motions of natural celestial bodies. Studies of variations in the orbit of 1958 Beta ("Vanguard" I) indicate that the traditional concept of the earth as a spheroid equally flattened at both poles and bulging at the equator must be slightly modified. Actually satellite studies show that the earth is slightly pear-shaped, the longitudinal axis of the pear being along the earth's axis of rotation and the stem of the pear being in the northern hemisphere. These results have important implications regarding internal stresses existing within the earth and concerning the mechanical strength of our planet.

Very recent results, also derived from the orbit of "Vanguard" I, indicate that the bulge around the earth's equator is about 500ft thicker than had been believed.† The equatorial bulge appears to be greater than can be explained by the "hydrostatic equilibrium" concept, according to which the earth's mantle is flexible and bulges under the influence of the earth's rotation It now appears that the bulge developed eons ago and that the mantle has since hardened and held its bulging shape.

Astronomy

The study of the heavens is an ancient science. During its early development, which lasted several millenium, visual observations soon revealed a number of regular phenomena such as the annual procession of fixed constellations across the firmament. The major planets, although erroneously believed to be "wandering stars," were identified and named after the gods of Greek mythology. Great celestial events such as the occurrence of eclipses, the display of unusual meteor showers, and the appearance of comets were viewed with awe and recorded in the chronicles of history. Although astronomy expanded considerably during the past three centuries with the discoveries of the telescope and of the spectroscope, three decades ago this science was still limited to investigations in the visual spectrum. Radio astronomy, which developed primarily after World War II, opened a new and much wider window through which the skies could be seen. However, a large portion of the electromagnetic spectrum of the universe is absorbed in the earth's atmosphere and can never reach an observer on the ground. The progress made in the field of rocket astronomy during the past decade shows that this last limitation is now rapidly being overcome. An unimpeded view of the universe is, of course, essential to the solution of many fundamental astronomical and cosmological problems such as establishing the distribution of energy and matter in space, or determining the origin, evolution, and destiny of the universe (Fig. 2).

Rocket Results.—Rocket astronomy is being pursued vigorously by scientists in the United States. Their results, which have been obtained by both spectrographic and photometric techniques, fall into two broad categories: (1) the extension of previous knowledge, and (2) the opening and pioneering of new fields. The two examples which follow will illustrate work done to clarify already known phenomena. Radio fade-outs which first attracted attention in 1927 remained unexplained until a series of "push-button" rocket flights conducted during I.G.Y. conclusively demonstrated that hard solar X-rays were responsible for the enhanced "D"-layer ionisation during these fade-outs. The 100km uncertainty in the height of the emission layers causing the night-glow was reduced to within a few kilometres by the first rocket flight instrumented for this measurement. In both cases very rapid progress was made by using rockets to solve long-standing problems.

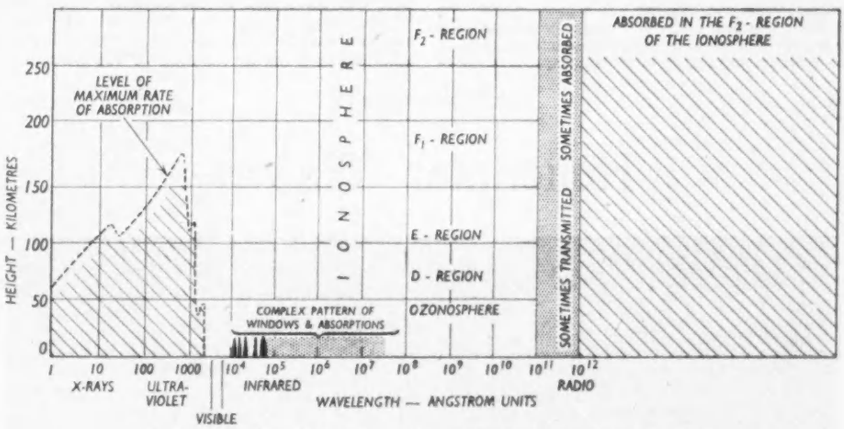


Fig. 2—Absorption of electromagnetic radiation by the Earth's atmosphere

New fields were unveiled by rocket astronomy in solar, interplanetary and galactic studies. The solar spectrum, previously unknown below 3900 Angstroms, has now been quite thoroughly investigated down to about 1 Angstrom. Below about 1800Å the continuum gives way to an emission line spectrum. The most prominent feature in the far ultra-violet region is the very intense Lyman alpha line of hydrogen at 1216Å. This radiation was also found to originate from all directions of interplanetary space. Very recently the sun was photographed in the light of the Lyman alpha line. Perhaps the most spectacular achievement was the unexpected discovery of nebulae observable only in the far ultra-violet region of the spectrum.

Satellite and Probe Results.—Data concerning micrometeors were obtained from the United States satellite, "Explorer I." These data indicate that 10^4 tons of meteoric material accumulate daily on the surface of the earth. Such meteor data provide basic information related to the composition and quantity of matter in interplanetary space. Also being measured are the penetration probability of meteors and their erosion rates for various surface materials. The effects of meteors must be accurately known in order to include adequate safety factors in the design of vehicles for space research and space travel. Effects of meteors can be detected also in the earth's atmosphere, as evidenced by correlations between meteor showers and rain precipitation or by the presence

† It is understood that these findings and the inferences may be modified after comparison with other observations.—Ed., The E.

of ionisation along meteor trails in the "E"-region of the ionosphere. The ionosphere, however, is produced primarily by the solar ultra-violet radiation, with occasional enhancements from X-rays, as established conclusively by rocket astronomy. These examples of the overlapping ramifications of the various disciplines are typical of the close relationship between the different areas of upper atmosphere and space research.

Biosciences

New fields of medicine and biology have recently developed as a result of man's increased success in leaving terra firma, his natural environment. The age-old desire of overcoming gravity was first realised with the balloon ascent of Pilâtre de Rozier in 1783 in Paris. The Wright Brothers in 1903 achieved the first dynamic flight with a heavier-than-air vehicle. The third step, namely flight without any support by air, has now come into being.

In conventional balloon ascents, the medical problems extend no further than oxygen deficiency and extremely cold temperatures. The numerous medical problems presented by flight in propeller-driven and jet-driven aeroplanes have, during the past forty years, led to the development of aviation medicine. Space medicine, initiated in 1949, is concerned with the even greater medical problems presented by space operations. Typical problems are the effects of high acceleration, weightlessness, extended isolation, and harmful radiation. Many of the problems overlap into the field of space engineering, such as meeting the food and respiration requirements of astronauts. In a broader sense, the opportunity now exists to conduct fundamental life sciences research in extra-terrestrial environments.

With the appearance of vehicles capable of reaching the moon and planets, there will also be the opportunity to look for evidence of extra-terrestrial life forms. This is, in fact, one of the most exciting prospects of space research.

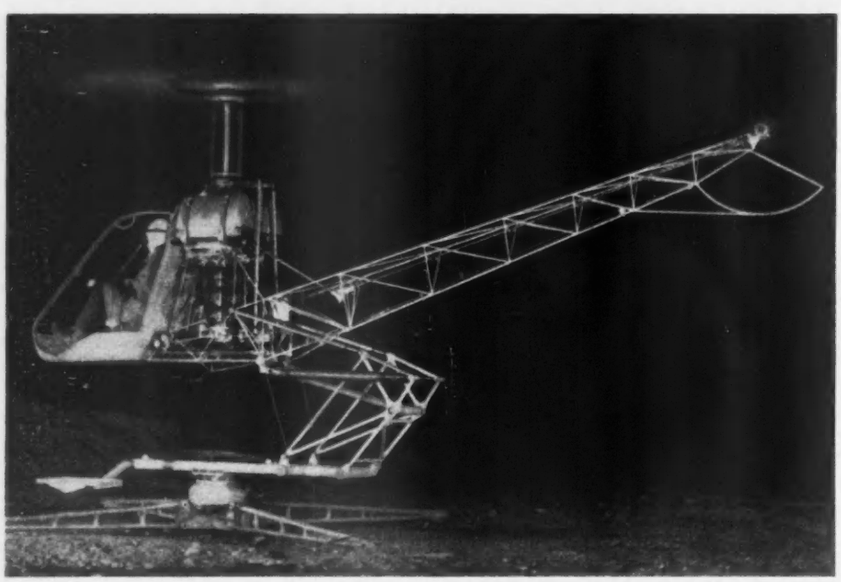
Rocket Results.—Monkeys and mice, flown in a rocket from New Mexico in 1953, were subjected to accelerations up to 14*g* without any apparent harm. To determine factors which affect tolerance to weightlessness, one mouse had its balancing organs destroyed but was taught to do without them. This mouse appeared comfortable during the rocket flight, as shown by a movie taken in the rocket, while the other mouse with a normal sense of balance showed signs of distress indicated by its frantic motion. Soviet experiments of this type have included rocket flights and recovery of dogs, who showed no evidence of harm from their trips into space.

Very recently (May 28, 1959) the United States launched two female monkeys 300 miles into space and brought them back alive and well. Telemetered data indicate that these monkeys suffered only slightly, if at all, from the stresses of take-off and the strange sensations of weightlessness. Several tiny samples of animal and vegetable matter were also carried in the nose cone for additional studies of the effects of cosmic rays and weightlessness. Some success in evaluating these effects may be achieved since the samples were recovered in good condition.

Satellite Results.—The most spectacular biological experiment conducted in a satellite to date was performed by the Soviets. The flight of the dog "Laika" in "Sputnik II" has received such world-wide publicity that further elaboration is hardly required in this summary.

(To be continued)

Helicopter Trainer



"Bö-102" helicopter on fixed base, to which it is attached by a parallel motion linkage which is free to rotate

AMONG innovations shown at the recent Twenty-third Salon Internationale de l'Aéronautique at Le Bourget* was the helicopter trainer "Bö 102" of Bölkow-Entwicklungen K.G., Ottobrunn, near Munich. It is intended to provide safe and cheap basic training at a cost per hour of about one-fifth of that of a normal machine. The equipment, which is illustrated on its stationary pivot mounting, is also intended to be used on a float. It is a single-seater, with a single-blade rotor of 6·57m blade circle diameter, equipped with counterbalance weight, and powered by a three-cylinder, two-stroke "ILO L3×375" engine developing 40 h.p. at 3000 r.p.m. The blade is made of glass fibre reinforced plastic and has a fixed dihedral angle of 2 deg. The semi-rigidly gimbal-mounted rotor head can revolve at up to 615 r.p.m. A glass fibre reinforced plastic counterbalanced single blade is also used for the tail rotor which is driven by the engine through shafting and bevel gears at up to 4000 r.p.m. The main gearbox has a planetary 4·88 : 1 reduction and free wheel.

With float and inflated stabiliser ring, the principal dimensions are: length, 5·91m; height, 2·80m; stabiliser diameter, 3·46m; lift, 0·60m. The weight is 454 kg on pivot mountings and 520 kg with float and stabiliser, and the machine is designed to carry 200 kg payload, comprising pupil, instructor and fuel.

The controls include swashplate control stick, blade pitch lever with twist grip for engine control and synchronisation, and adjustable pedals for directional control. A double speedometer, oil temperature indicator, electric starter and 12V battery, complete the equipment. The two fuel tanks together hold 66 litres (about 17½ gallons). With a 25 : 1 mixture strength, the machine is stated to use about 10 litres per hour of two-stroke mixture.

Instruction is carried out in two stages. With the trainer on its pivoting parallelogram mounting, and both the vertical movement and the rotation blocked, the pupil begins with learning how to start and stop the engine and how to synchronise speed and blade angle. With free rotation about the vertical axis, he practises torque compensation at various pitch and speed settings, and learns to maintain a steady rate of turn to either right or left. With rotational movement locked, but vertical movement free, he is taught how to take-off, hover and land without using the pedals or the control stick. Finally, with all movements free, he practises combined movements, landings without using the stick, and auto-rotation landings from the hovering position. This part of the training requires one to three hours. The instructor is seated outside the cabin on a seat attached to the rotating frame and in this way can follow the actions of the pupil and give instructions.

In the second stage of training, which requires from five to ten hours, the machine is mounted on the float. The following manœuvres are practised: hovering, fore, aft and lateral flight, turning on the spot, flying squares while heading in one direction and with 90 deg. turns, turning while moving forward and auto-rotation from hovering flight. It is claimed that this course enables pupils to fly solo after a further one to two hours in a dual-control trainer. Besides its use as an *ab initio* trainer, the machine is intended to assist pilots on refresher courses to regain the "feel" of helicopter flying, and to be used for testing applicants for pilots' courses under realistic conditions.

* Emergency issue of July 24, 1959.

Fifteenth Colloquium on Heat Treatment

This year's Colloquium of the Wissenschaftlich-Technische Arbeitsgemeinschaft für Härtereitechnik und Wärmebehandlung e.V., Bremen–Lesum, will be held on October 20 and 21 at Wiesbaden. The programme which, as always, includes an ordinary general meeting of the Scientific-Technical Working Group for Metal Hardening and Heat Treatment, will also comprise a series of sixteen lectures on a variety of metallurgical topics, each of which will be followed by a discussion. In connection with the congress the Working Group is holding a discussion meeting for its members and invited guests on October 19, with the main theme "Recent Developments of Inductive Heat Treatment, in particular in connection with thermo-chemical reactions." It is intended to deal in this section not only with the physics of heat treatment but also with new plant and processes, more particularly induction hardening. The official languages of the congress will be German, English and French. Those interested should contact the Secretariat, Institut für Härtereitechnik der Wissenschaftlich-Technischen Arbeitsgemeinschaft für Härtereitechnik und Wärmebehandlung e.V., Bremen–St. Magnus, Postfach 13.

Ultrasonic Remote Control

In the past very little use has been made of the possibility of controlling equipment over a distance by means of ultrasonic vibrations. It is therefore of interest to note that at this year's Radio Show in Frankfurt-on-Main, Siemens-Electrogeräte Aktiengesellschaft, Berlin and Munich, showed an ultrasonic control box for operating a television set from up to 15m away. By pressing the relevant button one can vary continuously the sound volume and the image contrast, as well as switch over to another channel. The equipment is run on a 9V dry battery and uses modulated sound of 24 kc/s.

International Motor Show at Frankfurt

No. IV—(*Concluded from page* 370, *October* 2)

IN the preceding issues we have described some of the new vehicles seen at Frankfurt : we now turn to a more detailed study of the designs, taking examples to show the trends of development.

Technical Developments

As far as the chassis of goods vehicles are concerned, there is no significant change, as the standard frame does not permit any substantial savings of weight without sacrificing its strength. It is generally believed that any potential saving of weight by the use of light-metal or plastic material should be restricted to the less severely stressed parts of the superstructure, the driver's cabin, the wings, and so on.

Suspensions, also, have changed very little : at the rear, auxiliary springs, either coil springs or hollow rubber springs are more frequently used, and for some purposes, for instance for the transport of fragile goods, air-sprung rear axles are sometimes offered. Worm-drive rear axles are not being used in Germany either for goods vehicles or for auto-buses and coaches, but the hypoid drive, as a useful means of lowering the transmission line, is coming more and more into use. The same applies to the two-speed axle with pneumatic or hydraulic actuation of the epicyclic gear ratio. Independent front suspensions of the wishbone and coil spring type are standard equipment of the 2·5 tonne Hanomag "Garant" truck. The increased application of the forward control and the resulting higher loading of the front axle has naturally stimulated the adoption of steering layouts requiring less physical effort, for instance, the Gemmer or the re-circulating ball steering or, in the case of very heavy vehicles, a power-assisted steering system. A good example of the latter construction is the Gemmer-Hydro steering of Zahnradfabrik Friedrichshafen in which all components of the servo-mechanism (apart from the oil pump) are within the housing of the steering column.

No particularly new trends were apparent in the design of the brakes ; hydraulic brakes predominate in all but the heaviest vehicles, and servo assistance by compressed air is almost universal. Full air-pressure systems are generally confined to heavy goods and passenger vehicles, but combined systems, using the air-assisted hydraulic brakes at the front and air-pressure at the rear, are also employed. The exhaust brake is standard equipment for the great majority of vehicles fitted with diesel engines. A useful device to reduce driver's fatigue in busy city traffic is the air-pressure operated "stop" brake of a Mercedes bus which, actuated by a small lever at the instrument board, replaces the ordinary hand brake. A similar device, in this case an air-assisted hand-brake, is fitted to a 6·5 tonne M.A.N. truck.

Measures for increasing the driver's comfort have made further progress : cabins made of steel, light-metal or plastic material, are better sound-proofed, heated and ventilated, the adjustable seats are well sprung, and—in some long-distance vehicles—such amenities as sunshine roofs, berths and lockers for the relief driver are provided (Fig. 15). Apart from the already mentioned servo-assisted steering and brake layouts, much thought has been devoted to the reduction of the physical effort of driving, in particular to gear changing by servo-assisted clutches and by fully synchronised gearboxes.

There is a noticeable decline in the use of constant-mesh gearboxes which, for medium-weight goods and passenger vehicles, are gradually being replaced by fully synchronised four- or five-speed units. The new Z.F. "Synchroma" gearbox has eight forward and two reverse ratios : it contains in one casing two synchronised gear trains, arranged at the input side of an otherwise orthodox four-speed synchronised gearbox. The changeover from one gear train to the other is effected by means of an electrically actuated hydraulic or pneumatic servo-cylinder. A similar arrangement of two synchronised alternatively used gear trains at the input side of a five-speed, constant-mesh gearbox is available for very heavy goods vehicles. Buses for heavy city traffic are generally equipped with such well-known automatic or semi-automatic transmissions as the Voith "Divabus" or the Z.F. "Hydromatic" transmission.

No major changes were apparent in the design of diesel engines, in which field the pre-combustion chamber engine still dominates, mainly because of its insensitivity towards fuels of different grade, which makes it particularly suitable for multi-fuel operation. There was announced a new version of the Rootes "T.S.3" direct-injection two-stroke which by simple adjustment of the fuel pump can be run on gas oil, petrol up to 87 octane, kerosene, and turbine grades JP-3, JP-4 and JP-5 : this is claimed to be the most successful multi-fuel engine, but no reference has been provided to the evidence for this. Turbo-charging was less in evidence than one should have expected ; it appears

Fig. 15—Krupp long-distance tractor-trailer fitted with 168 h.p. two-stroke diesel engine

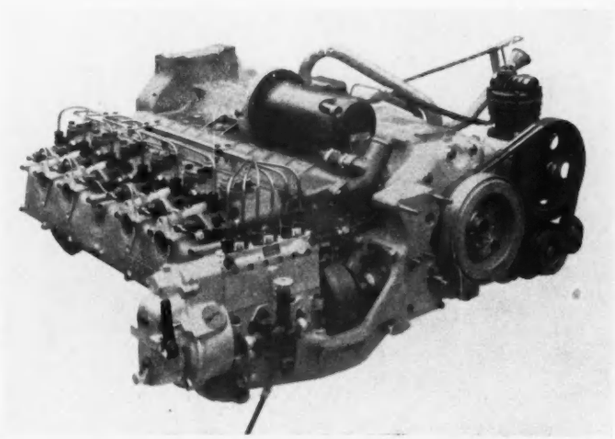


Fig. 16—Bussing 145 h.p. diesel engine designed for rear mounting

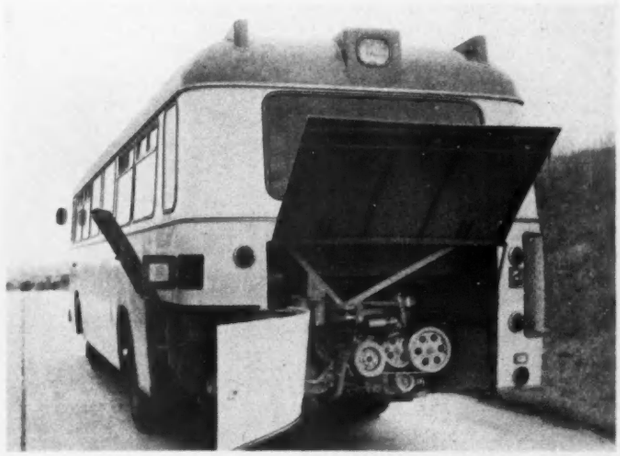


Fig. 17—Underfloor diesel engine accessibly mounted at the rear of a Bussing bus

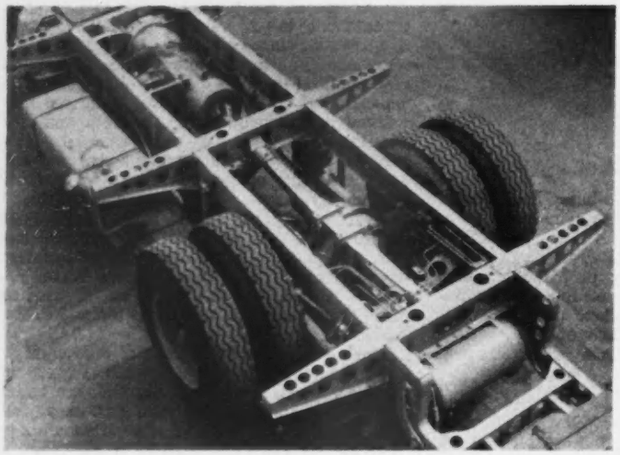


Fig. 18—Air-sprung rear axle, laterally located by a leaf-spring attached to the axle housing

Fig. 20—Interior of a Bussing articulated vehicle, showing the circular platform covering the trailer coupling

that any requirements for higher output can still be met by higher engine speed or by a small increase of the cylinder capacity. Examples of supercharging by a belt-driven blower of the Roots type were shown on the four-cylinder 2·8-litre engines of Hanomag and the 4-litre and 6-litre Henschel engines. Fried. Krupp showed a drastically redesigned 120 h.p., 3·25-litre, four-cylinder, two-stroke engine with uniflow scavenging, characterised by a cylinder head and cylinder block of light metal, and an overhead camshaft which directly actuates the exhaust valves. The air-cooled diesel engines displayed by Magirus have been considerably improved by the addition of a thermostatically controlled hydrodynamic drive to the cooling fan.

The vertical six-cylinder engine, with a few exceptions, dominates the field of goods vehicles, while the horizontal under-floor engine, originally built only by Büssing, has now been adopted by practically all the other manufacturers of public service passenger vehicles as an alternative to the forward- or rear-mounted vertical engine. Although under-floor engines are mostly arranged midships, they can also be mounted at the rear of the vehicle. A new Büssing 145 h.p. engine, designed for this particular purpose (Fig. 16), has most of the parts requiring service and replacement in an easily accessible position.

The design of public transport vehicles in Germany has made considerable progress in the last few years, mainly in the direction of lightweight construction. The bonnet has practically disappeared, and all modern vehicles, made for the home market, are now fitted either with forward control or with under-floor or rear-mounted engines (Fig. 17). The economic need for further improving the present laden to unladen weight ratio of about 1 : 1 has generally led to the replacement of the conventional chassis by either the integral body-cum chassis construction or, more frequently, by the semi-integral construction. In the former case the complete body structure is designed as a skeleton, formed by light frames or by welded square steel tubes, and covered by steel or light-metal panels ; alternatively the panels, spot-welded to the framework, can take a substantial part of the stresses. Examples of the latter design in steel, as well as in aluminium, could be seen at the stands of Henschel and Magirus.

Most manufacturers prefer the semi-integral construction, in which the floor is formed by a rigid structure, built up from fabricated steel sections, strong enough to make the frame driveable without the body. This construction acquires its full load-carrying capacity by the addition of the body which, bolted or welded to the underframe, substantially increases the torsional and bending resistance of the complete structure. City buses and coaches of this design were exhibited by Büssing, Daimler-Benz, M.A.N. and others.

An interesting fact evidenced by the passenger vehicles on show was the great variety in the design of wheel suspensions, which comprised almost every conceivable combination of rigid axles and independent suspensions with steel springs and air springs. Independent rear suspensions were represented only by a few examples, notably in two light buses, by Kässbohrer and by Krupp, apparently because of the considerable difficulties of transmitting higher torques through short, universally-jointed half-shafts. Increasing use, however, was made in light and heavy vehicles of the independent coil-sprung front suspension, employing double wishbones of uneven length and dampers, frequently in conjunction with hollow rubber auxiliary springs and stabilisers. The two latter components are also used increasingly for orthodox leaf-sprung rear-axle layouts.

The air suspension which, when first shown at the 1957 Frankfurt exhibition, created a minor sensation, has proved very successful in bus and coach operation ; it has been adopted by most manufacturers for such passenger vehicles where the payload equals or exceeds the unladen weight, and where a high riding comfort is essential. Here again the layout varied considerably. In some cases the rear axle only has air bellows as a spring element, and is paired either with a rigid leaf-sprung front axle or with a coil-sprung independent front suspension. Other vehicles, having air springing at the front as well as at the rear, used either rigid front axles or independently sprung front suspensions, the latter having the air bellows arranged between the wishbones and the body structure. In one case (Henschel) a composite system was shown, orthodox, semi-elliptic leaf springs fore and aft being used for the location of the axles and for carrying the static weight of the unladen body structure, and air bellows, interposed between the leaf springs and the body, to carry the variable passenger load. In another case (Büssing), a leaf spring, attached to the rear-axle casing, is used to locate the axle in the lateral direction, while the thrust, torque, and brake reactions are being taken by longitudinal trailing arms (Fig. 18).

We conclude our references to public service vehicles report by referring to one construction in which air-springing is widely used, namely, the articulated passenger vehicle (Fig. 19), a combination of a bus with a two-wheel trailer, both vehicles connected by a bellows to permit free passenger communication between the two parts (Fig. 20). Here the bus axles as well as the steered axle of the trailer are generally air-sprung, level valves at all bellows maintaining constant height from the ground, irrespective of any variations of the axle loading.

It is always interesting to visit the stand of the Volkswagen Werk in order to observe (and sometimes even to admire) by what comparatively simple means the " V.W." designers keep a car up to date, the original layout of which was actually conceived almost twenty-five years ago.

The Volkswagenwerk, with a production last year of 497,500 cars and 56,000 minibuses, light delivery vehicles and so on, is the largest motor-car producer outside the U.S.A. and, by a wide margin, dominates the German home market as well as export markets in the category of small motor-cars. More than 3,000,000 " V.W." cars have been built since the end of the Second World War ; there is no indication, so far, that

Fig. 19—Henschel articulated passenger vehicle for city and suburban traffic, built of aluminium in stressed-skin construction. Bus and trailer are fitted with air springing

Fig. 21—The extended nose of the latest version of the Goggomobil coupé encloses the 688 c.c. flat-twin four-stroke: a synchromesh gearbox is used

the demand is likely to slow down, quite irrespective of the fact that even the latest models are far from conforming to contemporary ideas of body styling.

In these circumstances it is not surprising that the 1960 models of the "V.W." are not different in appearance from those presented at Frankfurt two years ago. Practically all modifications are concerned with such mechanical detail improvements as are likely to enhance the functional value of the vehicle, in particular its roadability. For this purpose the centre of the final drive, and thus the differential, has been lowered by 15mm, and the entire engine-transmission unit is mounted with a 2 deg. forward tilt. The suspension has been made softer and more progressive in the upper deflection range, and a torsion bar stabiliser has been fitted at the front. The output of the generator has been increased from 160W to 180W in order to permit additional electric equipment to be installed; sound-proofing also has received attention, the revolutions per minute of the fan being reduced, the gear-shift coupling made softer, and more sound-damping material used in body and frame. There are also some improvements in finish and equipment.

An interesting contrast to the B.M.W. coupé described on page 320 (*ante*) was a radical modification of the widely known Goggomobil TS coupé. This car, it will be recalled, originally had the 300 c.c. parallel twin two-stroke and later the 400 c.c. engine was offered, in order that the performance should more fully complement the dramatically sporting appearance. However, the rear-engined version had a very finely balanced weight distribution, giving extraordinarily sensitive handling, and no further increase in power from an engine already yielding a high specific output could be expected. In order, then, to produce a car more suitable for the fast highways of the Continent than for the winding roads and slow-moving traffic of Great Britain, a larger engine was adopted. The engine is basically that of the "Isar" 700 saloon—this engine was originally intended to drive the front wheels of the saloon—and the new coupé has been designated "Isar" S-35, the power having been increased to 35 h.p. at 5700 r.p.m. (the B.M.W. engine contrasts in being a derated version of the motor-cycle unit). Visible differences on the engine include the facts that the twin carburetters are no longer close together on a manifold but each serves its own cylinder, and are of the horizontal-choke design. Two features of particular interest to the English observer are the compression ratio of 9·2 and the retention of a dynamotor to give silent starting. The distinctive diaphragm spring clutch of the later Goggomobil designs is used; synchromesh was not used on the previous coupés, in which there was a reduction train before the clutch, but presumably much less gear changing will be necessary with the larger engine. (The maximum torque speed has not risen from 3500 r.p.m.) The increased weight and speed—85 m.p.h. is claimed—justified an increase of wheel size from 10in to 12in for the same tyre section of 4·80in, so that even the tyres are common with the "Isar" saloons. There can be few, if any, precedents for modifying a car from independent suspension to Hotchkiss drive, but one attractive, if incidental, result of this extremely severe revision of the design is that the coupé has lost its striking resemblance to a water-cooled car. (See page 500, October 4, 1957.)

We conclude our report on German motor vehicles with a short description of the Fichtel and Sachs "Saxomat" automatic clutch, a gear-change help which in Germany is quite extensively used and is offered as optional equipment for most of the popular makes. Since its introduction two years ago (page 468, Sept., 27, 1957) the "Saxomat" has been considerably improved; it now has two friction clutches instead of one, namely, a large diameter centrifugal clutch which takes the torque when starting from rest, and a small, vacuum-controlled clutch. The large clutch, engaging between 950 r.p.m. and 1500 r.p.m., is energised by roller-shaped weights which move outwards between the tapered faces of the flywheel rim; the smaller clutch is disengaged during gear-changing by a vacuum servo-cylinder. Although no synchronising device is incorporated, the engagement of the small clutch is said to be smooth enough to permit quick gear changes to be made without any noticeable jerk.

Institute of Management Sciences

CONGRESS IN PARIS

By F. DE P. HANIKA

ACCELERATING technological change has long been recognised as the outstanding characteristic of the times in which we live. Yet, management responsible for guiding development and exploiting new methods, new materials, new processes in order to improve the well-being of society by giving it better standards of living, often enough still tries to make do with the elementary applications of scientific thought F. W. Taylor propounded sixty years ago (now labelled work study, industrial engineering, or simply productivity techniques). This makes the contributions designed to provide managers ultimately with better tools of analysis, communications and control, dealt with in the seventy papers read by scientists from various fields—economics, engineering, sociology, psychology, political science—at the Sixth International Conference of the Institute of Management Sciences in Paris last week, important, although not all of them are directly helpful or of immediate practical relevance at the present stage of management research.

The value of that meeting—the first held in Europe which united scientists from different disciplines and men from industry in common endeavour on a substantial scale—lies in the new ideas it brought to bear on old problems for the 700 participants from France, Britain, the U.S.A., Germany, Finland, Japan, Poland, Denmark, Norway and Sweden. The volume of material offered in the four days—the printed proceedings will run to well over 1000 pages—allows no more than highlighting the main stream of thought made apparent in the fourteen three-hour sessions.

Mathematical techniques for problem solutions familiar to operations researchers were much in evidence at most sessions irrespective of subject but elegance of mathematical method is lessening; the realism or "truth" of the model in relation to the situation it is desired to study assumes correspondingly greater importance. "Management Exercises" and "Business Games"—a by-product of simulation research—may be considered to "have stolen the show." In essence they amount to a simulation (akin to the sand-table exercises used in military staff colleges) of marketing, production scheduling and similar business problems. The value of such exercises for making soundly based decisions through developing capacity under pressure appears to be now accepted as undeniable.

Teams, each composed of three or four "players" compete (in separate rooms) for a share in a limited market or of scarce production resources by trying to deploy the means at their disposal (advertising, product development, machine replacement—all of which will deplete their cash resources) as intelligently as they can. The umpires in charge of the game call for reports from the teams at twenty-minute intervals, work out the effect of team activities on the total situation and pass back the result, when a fresh cycle of operations commences. Each period is taken to represent three months' trading, so that a day will suffice to simulate some eight to ten years of business life. Umpires may vary the limiting conditions (e.g. depression or economic expansion) and any specific business can—albeit with some simplification of its total situation—be construed into such a model. This kind of laboratory study of business problems will play an increasing part in management training of the future.

The contention that such exercises are valuable finds support through the recognition—explicitly or by inference—in all the papers, of the management task as the control of a combination of systems, each composed of inter-acting forces of its own, with really tough problems arising wherever specific systems (material supply, labour conditions, government regulations, &c., &c.) themselves interact with one another. In this context, the report in "Fundamentals of Management Education" on a course provided at "Chesters" (the residential centre for management studies of The Royal College of Science and Technology, Glasgow) is relevant. Under the title "Systems Analysis," training in logic, statistical method and the concepts of cybernetics is made to serve managers who are interested in improving their handling of problems by systematic analysis of interactions.

The conference opened with an examination of "Management Economics." Already the subject of several text-books, the title extends the field of "Engineering Economics" (usually seen in terms of production costs) to market elasticity, price formation, marketing and advertising effectiveness under varying conditions.

Professor Whitin of M.I.T., made the point that "macro-economists" studying the economy as a whole are mistaken in their notion that entrepreneurs necessarily act rationally in the sense of aiming to maximise their profits to the exclusion of other considerations. Hence "micro-economics" concerned with the economic behaviour of the individual business unit as an input/output system must seek to dissect the production scheduling and time-sequencing problems "usually ignored in conventional economic theory" when it assumes that the production function solely depends on the initial choice of factors, learning and specialisation.

After disposing of simulation, management games, management education, decision processes and computery, attention turned to production and inventory management where Professor Wagner (Stanford) stressed the need for both stock-policy and financial controls. Insistence on both for inventory management may at first sight appear paradoxical but the former is often incomplete in itself and in any case ill-suited to include procedures for detecting and recognising change at an early stage. Moreover, financial controls can check the validity of the common presumption that stock policy is fully implemented throughout and at all stages. Professor Litauer (Columbia) surveyed the structure desirable in an "Industrial Development Advisory Group." Shorn of some of the more extravagant phraseology ("intense development of general methodology for the solution of socio-economic problems") a valuable discussion of the relevant decision criteria remains, complete with specimen checklists for planning problems and an even more detailed one on economic control of quality. His comments on the importance of classifying industrial variables, the formulation of the range of decision problems involved and the building of operational models do much to bridge the gap between the down-to-earth approach used by the work study man or industrial engineer and the more sophisticated patterns employed by operations researcher or professional systems analyst.

Papers on "Measurement for Management" ranged from reiteration of the long-felt want for measures of managerial effectiveness other than profits, to a fully documented, interim research report by Professor Revans (Manchester) concerning the effect of hospital communications systems on the stability of nursing (and possibly domestic) staffs, as well as on the length of in-patient stay. Communications are defined as "not so much written material as the entire system of human contacts or its absence, including the extent to which the hospital committee are used to give decisions, the formality of contacts between matron and sisters and—above all—the subtle but powerful influence of the status system." Student nurses saw unintelligibility of their ward duties as their greatest fear. It is suggested that significant differences in the mean period of stay by in-patients of the same clinical category, randomly admitted to different hospitals (reported by the Nuffield Provincial Hospitals Trust) may be due to assignable differences in the respective communications systems of admission (contact with outside agencies), diagnosis (collection of records, dealing with specimens, X-rays, &c.), treatment (including pre- and post-operative procedures), control (the sub-system by which the effect of the treatment is compared with the effect expected when the diagnosis was made). The widespread interest in communications by management in industry gives this study considerable potential value by way of comparative findings.

A contribution from the Tavistock Institute of Human Relations (Trist and Emery) provided the sessions on the "Behavioural Sciences" and "Organizational Theory and Management Communications," with a sound foundation by reviewing the present state of knowledge on task/role structure in working groups within the entity of the enterprise as a social system, touching on distribution of reward and risks and discussing the basis of solidarity and the individuality of enterprise against the background of the frequently opposing trends and strains inherent in the management of advanced technologies, not forgetting the psychological difficulties inherent in committee management. Other papers explored specific aspects of this overall theme; one considered a generalised, predictive theory in the field of sociology to be "necessarily unobtainable," and suggested no more than a better understanding of the activity of management, as the proper aim of the management sciences. Time will show!

"Research and Development Management" brought American attempts to define and measure the manpower effort called for by specific projects and how best to determine the amounts to be allocated for research expenditure in the total company budget. The discussions which followed failed to produce any generally acceptable conclusions in this admittedly very difficult field, which will require much more investigation before generally valid conclusions are likely to emerge.

"Corporate Long-Range Planning," on the other hand, proved very helpful with its papers from three French sources, the University of California and Lockheed Corporation. The last found operational research successful with problems on levels below top management, based on well-understood underlying theory (and past relationships likely to continue into the future), which are sufficiently well structured to allow quantification of relevant variables and permit solutions to be stated in numerical terms when handled by systematic computational routines. The position is seen differently for the strategic problems facing top management—product, market, research policies, diversification and allocation of corporate resources—which call for overall optimisation, although no overall criterion of effectiveness is available; they are not quantifiable and require judgment in arriving at a solution.

A quasi-analytical method is suggested instead halfway between the operations research approach and the heuristic method, which traditionally abstains from general principles altogether and confines itself to evaluation of competing conclusions by logical reasoning and the passage of time. As outlined, the procedure is process-oriented rather than goal-oriented. Qualitative judgments "embedded in the problem structure" are utilised but checked by continuous feedback between analysis and problem formulations to construct a self-correcting theory of the business as it proceeds. Simultaneous treatment of the frequently mutually exclusive business objectives identifies sets of dominating alternatives by dividing the strategic problems into internal and external ones and then subdividing each problem into its quantitative and qualitative sub-problems. The field is thus progressively narrowed down by eliminating alternatives as additional decision criteria emerge; applying some weighting procedure to the residual set of alternatives which remains then produces the final solution.

Compared to the purely heuristic and intuitive approach, this methodical treatment is claimed to prove superior by virtue of the comprehensiveness and validity secured in abstracting the real life situation whilst avoiding mathematical rigour inappropriate where the problems elude adequate quantification. No doubt, most successful men of business have long developed individually, and employed habitually, some such mental process before bringing their intuitive judgment to bear; such a clearly set out step-by-step procedure has, however, merit in enabling others to develop their decision-making skill more easily and quickly whilst, at the same time, increasing justified confidence in the results.

Sessions dealing with case studies and questions of methodology concluded the official proceedings. Some delegates paid a (literally) flying one-day visit to Amsterdam for a joint meeting with the Econometric Society; most of the rest remained to participate in the demonstrations of management games arranged by the conference organisers when the surprisingly wide and keen interest in these exercises made itself apparent.

Taken all-in-all, the fourteen sessions managed to provide in the brief span of four days a comprehensive review of current developments in the management field. There is healthy promise of much-improved comprehension of the why's and wherefore's of management activities, both severally and—much more importantly—also jointly. Such an outcome cannot fail to benefit the conduct of the economic affairs of the nation by better planning, direction and control of resources within each individual business undertaking. Many of the concepts and methods are bound to prove strange to managers wont to rely exclusively on direct personal experience in conducting the affairs entrusted to them. It seems, therefore, that the engineer who, for quite a long time, has had a foot in both camps—science, on the one hand, and the day-to-day problems of practice, on the other—has an important contribution to make if the country is to reap the fullest possible benefit from the management sciences emergent.

Electric Pumps for Agriculture

As additions to the range of electrically driven pumps, Siemens-Schuckertwerke Aktiengesellschaft, Berlin and Erlangen, recently put on the market two portable pumps, the "LPW38" and "LPW48," designed to deliver 2·5 cubic metres per hour and 5 cubic metres per hour, respectively, against a head of 30m H_2O, the installed power being 1·1kW and 2kW. We illustrate the model "LPW48," which, like the smaller pump, is mounted on a rubber-tyred chassis with handle and parking leg. The

Self-priming pump of 5 cubic metre per hour delivery

pump is on the same shaft as the three-phase motor, with which it forms a unit. It is self-priming and can supply three commercial sprinklers. In order to protect the pump from the effect of the presence of sand in the water, the casing is made from wear-resisting materials. The axially fixed runner is double-sided in the larger model. In combination with air-loaded pressure tanks and pressure-operated switches, the pumps form a self-acting water supply plant.

Selective Filter for Television Screens

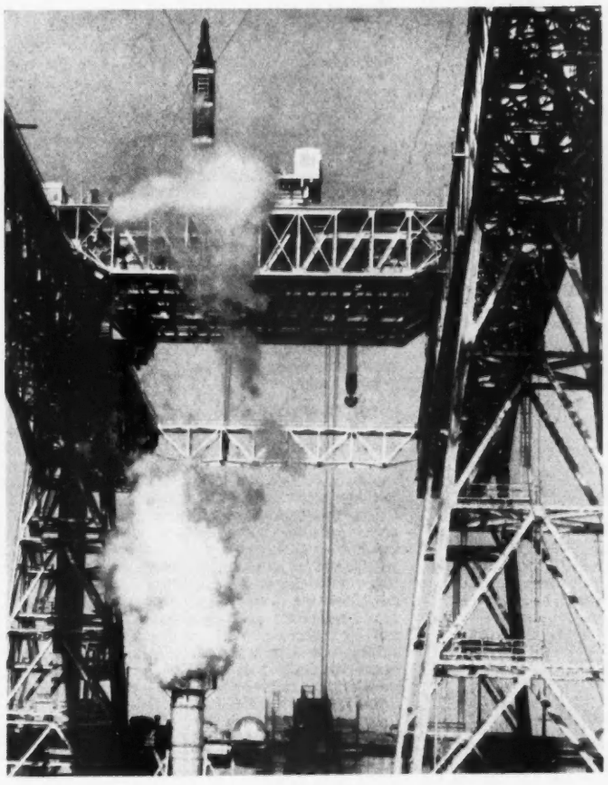
Eyestrain and fatigue is held by some to result from watching television screens in darkened rooms, the remedy being to operate the set in surroundings with a reasonable degree of illumination. If this is done, however, a large amount of light is reflected from the front of the glass and contrast is reduced. In order to improve matters, Siemens-Electrogeräte Aktiengesellschaft, Berlin and Munich, has introduced a selective filter to be placed over the television tube. This filter absorbs most of the wavelengths present in the ordinary white spectrum which is continuous, but allows those light waves to pass which make up the "white" light of the fluorescent screen, i.e. yellow and blue bands. The differential effect is increased by virtue of the light from the screen passing the filter only once, but the light reflected from the tube, twice. An improved version of the filter also takes into account the varying sensitivity of the eye to different colours.

Recovery of "Polaris" Dummy Missiles in Mid-Flight

BY OUR AMERICAN EDITOR

IN "Operation Skycatch," one phase of development testing of the launching system for "Polaris," the U.S. Navy submarine-launched ballistic missile, full-scale dummy missiles are caught in mid-flight. The test programme leading to the final production of a ship-borne launcher began many months ago at the San Francisco naval shipyard as a joint effort of the Westinghouse Electric Corporation, in charge of the launching system development, and the Lockheed Missiles and Space Division, in charge of the "Polaris" missile system, in conjunction with U.S. Navy personnel. In tests preceding "Skycatch," first large redwood logs and subsequently full-scale concrete-filled dummy missiles were hurled from launching tubes and then recovered from the San Francisco Bay. The dummy missiles carried strain gauges and other instrumentation to show the sudden acceleration forces of launching. Similarly, dummies were launched from a submerged launching tube off the Southern California coast primarily to test the launching system itself.

With "Operation Skycatch," testing reaches a more advanced stage, which is providing more complete information on how the missile will withstand the launching procedure. The dummy missiles are now structurally identical metal replicas of the actual live "Polaris." A simple recovery technique was needed to make possible the study of launching effects on the missile, without subjecting it to the damage of violent impact with the water. The structural test vehicle was less rugged than its concrete-filled predecessors, and the test engineers wanted it to carry much delicate instrumentation. If it landed in the water, as in the past, the tests would be valueless and the equipment destroyed. A device was needed which would permit the recovery of the missile and its instruments intact, permitting reuse and saving thousands of dollars per test. The solution to this dilemma was obvious: to catch the missile in the air, at the highest point of its trajectory. An ingenious method of giving the huge missiles a "lift without a let-down" was devised by the Navy Aeronautical Engineering Facility at Philadelphia. Large overhead cranes, towering high above other shipyard installations, were fitted with a modified arresting gear engine, as normally used to shorten the runs of aircraft landing on aircraft carriers. Cables hanging from these cranes are attached to the test missiles before firing. As the "bird" is hurled upward, reaching its highest point, the cables are reeled in to put on tension and to stop the flight. The vehicle is then lowered gently to the ground.



Full-scale dummy "Polaris" ballistic missile being snubbed by arresting gear at top of its trajectory

Launching data, recorded on magnetic tape, perpetuates the readings of many instruments carried in the test missile or situated at the ground control station. This magnetic tape is then fed into an electronic brain at the Lockheed plant for analysis. The results are evaluated both at Lockheed and at the Sunnyvale manufacturing division of Westinghouse, where development work is being conducted on the "Polaris" launching system and the production of launchers for the nuclear-powered fleet ballistic missile submarines. The first of these submarines, the U.S.S. "George Washington," is scheduled to become operational in 1960.

American Nuclear Propulsion Plant for British Submarine

THE Westinghouse Electric Corporation has announced the formation of a new atomic power organisation for the purpose of procuring a nuclear propulsion plant for Great Britain's first atomic-powered submarine, the "Dreadnought." The United States has authorised the transfer to the United Kingdom of a complete "Skipjack"-type submarine nuclear propulsion plant, spare parts, design and related classified information. The authority for the transfer is contained in the amended Atomic Energy Act of 1954 and in the Mutual Defence Agreement for Co-operation between the United States and the United Kingdom, which became effective on August 4, 1958. As required by the Atomic Energy Act and the Agreement, a determination has been made by the President of the United States that the transfer of the plant and the communication of related data to the United Kingdom would promote, and would not constitute an unreasonable risk to, the mutual defence and security of the United States and the U.K.

In March negotiations were concluded between Rolls-Royce and Westinghouse, with the result that a complete set of machinery similar to that being installed in the latest U.S. Navy submarines of the "Skipjack" class will be obtained from Westinghouse. Besides procuring the atomic power plant for this British submarine, Westinghouse will also train the personnel of Rolls-Royce and the Admiralty in the design and construction of this plant so that they can build their own similar plants in the future. Vickers-Armstrongs, the firm building the "Dreadnought," has been authorised by the United States Government to obtain information and assistance from the Electric Boat Division, the U.S. shipbuilder which built the "Skipjack."

Award of John Fritz Medal

FOR the first time in the fifty-eight-year history of the award, the highest honour that American engineers can bestow will go to a man with a non-engineering background, for his vision and his industrial leadership in the development of atomic power. The John Fritz Medal Board of Award announced recently that the medal will be awarded to Gwilym A. Price, chairman of the board of the Westinghouse Electric Corporation. The presentation of the gold medal, awarded annually for notable scientific or industrial achievement, will be made at the annual meeting of The American Society of Mechanical Engineers at Atlantic City in early December. Wm. F. Ryan, a past president of the A.S.M.E. and a member of the Fritz Medal Board of Award, announced that the honour had been voted to the industrialist by the representatives of the four senior engineering institutions for "his inspirational leadership, industrial pioneering and personal initiative in marshalling the creative forces of research and engineering to the cause of developing atomic power for the national defence and for the human welfare." Mr. Price, at the end of World War II, saw the possibilities of harnessing the atom for practical uses and recognised the military significance of nuclear propulsion. He formed an atomic power organisation within his company which developed for the Atomic Energy Commission and the U.S. Navy the historic atom plant for the U.S.S. "Nautilus." From the atomic submarine pioneering, Mr. Price's engineers and scientists gained the know-how which they applied in their work on the nation's first full-scale atomic-electric generating station at Shippingport.

International Heat Transfer Conference in Colorado

AN International Heat Transfer Conference will be held in the United States from August 28 to September 1, 1961, at the University of Colorado at Boulder. The conference will be held under the joint sponsorship of the American Society of Mechanical Engineers, the American Institute of Chemical Engineers, the Institution of Mechanical Engineers and the Institution of Chemical Engineers. Also participating in the conference are the American Chemical Society, American Nuclear Society, American Rocket Society, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Chemical Institute of Canada, the Engineering Institute of Canada, the Institute of the Aeronautical Sciences and the Society of Automotive Engineers. The conference is being held for the purpose of making known new fundamental knowledge and practical developments in the field of heat transfer and to bring together the persons engaged in research, development, and application for discussion and exchange of information. This is the second such international conference, the first having been held in London in September, 1951. Papers are desired on recent original work or new applications of theory to practice. Abstracts of papers offered for the conference should be sent to S. P. Kezios, Secretary, 1961 International Heat Transfer Conference Committee, c/o The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N.Y., prior to August 1, 1960.

Personal and Business

Appointments

MR. R. S. READE has been appointed general manager of Goodenough Pumps, Ltd.

MR. WILLIAM WILSON has been appointed marine sales manager with Mirrlees, Bickerton and Day, Ltd.

SHARPLES CENTRIFUGES, Ltd., has announced the appointment of Mr. Keith J. Daniells as a chemical engineer.

MR. P. E. MONTAGON has been appointed manager of the research department of the Lightfoot Refrigeration Company, Ltd.

THE MACHINE TOOL TRADES ASSOCIATION states that Mr. H. O. Barrett has been appointed general manager and secretary.

MR. E. P. PURCELL, A.M.I.C.E., has been appointed to the board of directors of George Cohen (Dublin), Ltd., one of the George Cohen 600 Group.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION announces that Mr. J. R. Cowper has been appointed to the Coastal Shipping Advisory Committee in succession to Mr. E. W. Burness.

HICK, HARGREAVES AND CO., Ltd., announces that Mr. John J. Warburton, sales manager and special director, has retired after forty-eight years' service. He has been succeeded by Mr. T. Dougall.

MR. HARRY R. BARBER, chief engineer of the car body division of the Pressed Steel Company, Ltd., has been appointed a member of the Motorcar Body Divisional board as assistant director of engineering.

THE DISTINGTON ENGINEERING COMPANY, Ltd., branch of The United Steel Companies, Ltd., has announced that Mr. A. E. Bell has been appointed commercial manager and has assumed responsibility for the buying department of the branch.

MR. S. A. ROBERTS, M.I.Mech.E., has been appointed managing director of the B.S.A. Tools, Division. The main companies in the Division are B.S.A. Tools, Ltd., B.S.A. Small Tools, Ltd., B.S.A. Broach Company, Ltd., Burton, Griffiths and Co., Ltd., and B.G. Machinery, Ltd.

BRITISH STANDARDS INSTITUTION announces that Mr. R. E. Huffman has been re-elected for a second term of office as president. The three deputy-presidents, Sir Roger Duncalfe, Sir Herbert Manzoni and Mr. John Ryan, have also been re-elected.

THE COMBUSTION ENGINEERING ASSOCIATION announces that Mr. Andrew Laird has relinquished his post with the Association to take up another appointment. Mr. T. G. Edmondson has been appointed a technical officer in succession to Mr. Laird.

MR. ROBERT NIGEL BRUCE, deputy chairman of the North Thames Gas Board, is to succeed Mr. W. K. Hutchison as chairman of the South Eastern Gas Board at the beginning of next year. Mr. Hutchison is to become deputy chairman of the Gas Council.

DR. T. BEDFORD, who has retired from his appointment as director of the Medical Research Council's Environmental Hygiene Research Unit, has been appointed as consultant on heating, ventilating and air conditioning by Teddington Industrial Equipment, Ltd.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., has agreed to second Mr. L. A. Sweny, manager of the company's aeronautical division, to Hovercraft Development, Ltd. He has been succeeded as manager of the aeronautical division by Dr. B. J. O'Kane, A.M.I.E.E.

MR. L. L. BOYD, at present managing director, the United Steel Companies (India) Private, Ltd., and director, the United Steel Companies (Pakistan), Ltd., is shortly to return to the United Kingdom. With effect from March 1, 1960, he will take up the position of deputy commercial manager at United Steel's Steel Peech and Tozer branch, Rotherham.

FERRANTI, Ltd., announces the following appointments:—Mr. W. D. H. Gregson has been appointed assistant general manager of the company's Edinburgh factory and will take up his duties towards the end of this year. Mr. J. P. Newberry is to succeed Mr. Gregson as London area manager and Mr. P. McGregor becomes senior transformer sales engineer, London area, both appointments becoming effective from November 1. Mr. J. C. Heywood has been appointed sales manager of the electronics department and has been succeeded in the instrument department by Mr. H. L. Harrison as departmental sales manager.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., Motor and Control Gear Division, has announced that Mr. K. M. Fox, A.M.I.E.E., has been appointed manager of industrial machines department, Rugby. The Electronic Apparatus Division of A.E.I. announces the appointment of Mr. D. N. Relf, A.M.I.E.E. as manager, industrial electronic apparatus sales department.

MR. G. R. GILES and MR. H. S. HULL have been appointed directors of The British General Electric Company, Pty., Ltd., South Africa. Mr. H. J. Eley, manager of The General Electric Company, Ltd., E.S. and V. department, has retired after forty-one years' service. Mr. F. Sampson, manager of the G. and R. department, is to retire on March 31, 1960. Mr. I. M. Milsted has been appointed manager of the department and Mr. E. J. Masters, deputy manager.

Business Announcements

THE WEDNESBURY TUBE COMPANY, Ltd., Oxford Street, Bilston, Staffs, states that its new telephone number is Bilston 41133 (nine lines).

FILM COOLING TOWERS (1925), Ltd., announces that it has moved to larger premises at Chancery House, Parkshot, Richmond, Surrey (telephone Richmond 6494).

THE NATURAL ASPHALTE MINE-OWNERS AND MANUFACTURERS COUNCIL states that its new address is 14, Howick Place, Victoria Street, London, S.W.1 (telephone Victoria 1600 and 6477).

AEROX, Ltd., Ceramic Works, Hillington, Glasgow, S.W.2, states that it has outgrown its premises at Crawley and acquired a larger factory for its engineering section at Chalford, Stroud, Gloucestershire.

UNION CARBIDE, Ltd., 103, Mount Street, London, W.1, states that the business carried on at Grangemouth by its subsidiary company, Gemec, Ltd., has been transferred to, and is being continued by, Union Carbide, Ltd.

PROFESSOR A. J. S. PIPPARD, F.R.S., president of the Institution of Civil Engineers, is now on a visit to West Africa. He is accompanied by the secretary of the Institution, Mr. A. McDonald, former inspector-general of works, Nigeria.

NASH AND THOMPSON, Ltd., Surrey, states that it is now the exclusive selling agent in the United Kingdom and Commonwealth for "Kovo," the foreign trade corporation for the import and export of precision engineering products made in Czechoslovakia.

ALLIS-CHALMERS INTERNATIONAL has announced the establishment of Allis-Chalmers Italiana S.p.A., a majority-owned subsidiary of Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, U.S.A., and the acquisition by the Italian company of the facilities of Vender S.p.A., a manufacturer of crawler tractors and spare parts, located at Cusano, a suburb of Milan.

STONE-PLATT INDUSTRIES, Ltd., and the CARRIER CORPORATION, Syracuse, N.Y., have formed a marketing organisation, Carlyle Air Conditioning and Refrigeration, Ltd., 1, King Street, St. James's, London, S.W.1, to promote the manufacture in Britain and the sale here and abroad of American-designed air conditioning and industrial refrigeration plant. The Carrier Corporation has a controlling interest.

BRUCE PEEBLES AND CO., Ltd., has opened a branch office in Permanent House, The Headrow, Leeds. Mr. W. A. Mackay has been appointed manager of the Leeds office. The company has despatched the first two of three 90MVA, 275/66/11kV transformers to the Magill Substation, Adelaide, of the Electricity Trust of South Australia. The transformers will be used to link the main 275kV line from Port Augusta Power Station to the metropolitan system in Adelaide.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., and the Polish foreign trade enterprises, POLIMEX and TEXTILIMPORT, have signed in Warsaw an agreement which covers the purchase by Polimex of production know-how and a licence to enable a plant for polyester fibre to be built in Poland, and the purchase by Textilimport of polyester fibre which I.C.I. will supply to Poland during the years 1960–64. It is foreseen that the plant producing the Polish polyester fibre, under the name of "Elana," will be started up in 1963.

Contracts

TURRIFF-BURDEN, Ltd., has received from the Iraq Petroleum Company a contract for the immediate construction of 314 miles of 30in and 32in pipeline in Iraq.

BLACKBURN AIRCRAFT, Ltd., now has a full production order for a substantial quantity of N.A.39 naval strike aircraft for the Royal Navy in addition to the development batch of twenty.

HOLLAND & HANNEN AND CUBITTS, Ltd., started work on October 5 on the lecture theatre for the Royal Aeronautical Society at 4, Hamilton Place. Designed to hold 350, the theatre should be in use next October.

W. H. ALLEN SONS AND CO., Ltd., has received an order from the Warwickshire Division of the West Midlands Gas Board for the supply of two 175kW C.M.R. back-pressure single-stage steam turbines for direct coupling to Electric Construction Company alternators for installation in the retort houses at Foleshill Gas Works, Coventry.

THE EASTERN REGION, BRITISH RAILWAYS, has placed contracts with South Wales Switchgear, Ltd., and with Fuller Electric, Ltd., for the erection of equipment for feeder stations and track-sectioning cabins in connection with a.c. electrification at 50 c/s of the Enfield–Chingford–Hertford (East)–Bishops Stortford lines, and the conversion to that system of the Liverpool Street to Southend line. The feeder stations and track-sectioning cabins allotted to South Wales Switchgear, Ltd., are for a 6·25kV supply to the overhead contact line, and those to be equipped by Fuller Electric, Ltd., are for a 25kV supply.

THE CENTRAL ELECTRICITY GENERATING BOARD has placed contracts during the past two months for power stations, transmission lines and transforming stations totalling about £8,000,000. The principal contracts include the following. Northfleet power station, 6·6kV auxiliary switchgear for Nos. 4, 5 and 6 sets, South Wales Switchgear, Ltd. Blyth "B" power station, two 310MVA, 275kV, generator transformers, Nos. 5 and 6, Ferranti, Ltd.; ash handling plant, Holdan Engineers (London), Ltd.; boiler make-up water treatment plant, John Thompson-Kennicott, Ltd.; high pressure pipework and valves for Nos. 5 and 6 sets, John Thompson (Pipeworks), Ltd.; and 11kV switchgear and accessories, A. Reyrolle and Co., Ltd. Skelton Grange "B" power station, one 144MVA, 132kV, generator transformer, Hackbridge and Hewittic Electric Company, Ltd. Padiham "B" power station, railway sidings, Thos. W. Ward, Ltd. Thorpe Marsh power station, foundations for main buildings, Holloway Bros. (London), Ltd.; and coal handling plant, Robert Dempster and Sons, Ltd. Rheidol power scheme, Cwm Rheidol dam, pressure tunnel and power station, Taylor Woodrow Construction, Ltd. Trawsfynydd nuclear power scheme, reconstruction of dam and other reservoir works, Sir Alfred McAlpine and Son, Ltd. Uskmouth "B" power station, cooling water outfall works, Holloway Bros. (London), Ltd.; high-pressure pipework and valves for Nos. 1, 2 and 3 units, Babcock and Wilcox, Ltd.; coal ash and dust handling plant, civil engineering works, and circulating water ducts, M. J. Gleeson (Contractors), Ltd.; and reinforced concrete chimney No. 1, The Mitchell Construction Company, Ltd. Aberthaw power station, dust handling plant and coal handling plant, Babcock and Wilcox, Ltd. Whitfield substation, two 90MVA, 132/33kV, transformers, Hackbridge and Hewittic Electric Company, Ltd. Wolverhampton substation, one 60MVA, 132/33kV, transformer, General Electric Company, Ltd. West Weybridge substation, 275kV switchgear, A. Reyrolle and Co., Ltd. Stalybridge substation, 275kV and 132kV switchgear, English Electric Company, Ltd.; and site and foundation work, Turriff Construction Corporation, Ltd. Ribble power station substation, 33kV and auxiliary cables, Standard Telephones and Cables, Ltd. Agecroft/Frederick Road (Salford), 132kV vables, W. T. Henley's Telegraph Works Company, Ltd. Beeston Royds-Kirkstall, 132kV and pilot cables, W. T. Henley's Telegraph Works Company, Ltd.

Miscellanea

REVISED LIGHT CAR.—The new engine, gearbox and rear axle described in our account of the Ford "Anglia" in our issue of October 2, are now standard in the "Prefect." The existing final drive ratio of 4·429 is retained, the weight being unaltered at 15¼ cwt.

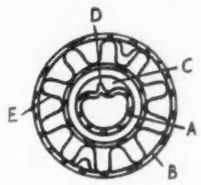
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings, unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

ELECTRIC LIGHTING

815,893. September 19, 1955.—Sodium Vapour Electric Discharge Lamps, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. (*Inventor: Sydney Alfred Richard Rigden.*)

One of the difficulties which has been experienced with sodium vapour discharge lamps is that after long periods of use the sodium tends to migrate to parts of the discharge envelope which remain relatively cool in operation, with a consequent reduction in the light output of the other parts of the envelope and a fall in the efficiency of the lamp. According to this invention, the elongated tubular discharge envelope between the lamp electrodes is formed with one or more regions of appreciably reduced area of cross-section and relatively short axial length. The reduction in the area of cross-section in any region of the discharge envelope has the effect of increasing the current density in that region in operation of the lamp, which tends to increase the operating temperature of that part of the envelope, and the possibility of migration of the sodium along the envelope from one side of the region to the other is thereby considerably reduced. Referring to the drawing, the discharge



No. 815,893

envelope *A* is mounted centrally within a cylindrical glass outer jacket *B*. A glass sleeve fits over the envelope and two spring members, one of which is shown at *E*, surround two widely spaced portions of the sleeve for preventing rattling. The discharge envelope is provided at one side near to the middle with a depression *C* which effectively reduces the cross-sectional area of the envelope in that region, the bore of the envelope having a cross-section of about 550 square millimetres at the centre of the depression. The depression is formed in the discharge envelope by heating the side of the glass tube from which the envelope is formed in the desired region and allowing the wall to collapse inwardly, the amount and duration of the heating being controlled to obtain the required reduction in the cross-section of the tube. Within the depression there is located the exhaust pip *D* of a tipped-off pumping stem, the location of the stem in this position enabling the sodium filling to be introduced into the discharge envelope without the sodium being deposited on the electrodes or electrode leads. After the introduction of the sodium and the gas filling the pumping stem is sealed off below the level of the cylindrical outer surface of the discharge envelope. so that the top of the exhaust pip which is formed is protected by the surrounding part of the envelope.—*July* 1, 1959.

PIPES

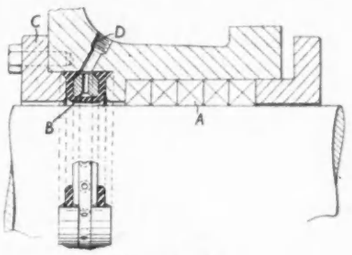
820,121. August 2, 1957.—Lining Pipes and Vessels with Polymer Plastics, T.I. (Group Services), Ltd., Rocky Lane, Aston, Birmingham, 6. (*Inventors: Arthur Charlesby and Solomon Harris Pinner.*)

It is proposed, according to the invention, to line cylindrical pipes and vessels with a polymer plastic which is cross-linked by subjecting it to irradiation from high energy electrons, X-rays, gamma rays or equivalent high energy radiation. This treatment converts the polymer into a form which retains its softness and ductility but does not melt at temperatures well above the normal melting point of the untreated polymer. The use of irradiation opens up the possibility of new methods of applying the lining or coating. In one such method, as applied to the lining of cylindrical pipes, a tube of the polymer is inserted in the pipe and saturated with a monomer which has the property of causing it to swell into contact with the walls of the pipe. The assembly is then irradiated to convert the monomer into polymer and render the swelling permanent. By using a monomer which also has an affinity for the material of the pipe it is possible to obtain simultaneously a true adhesion of the plastic to the pipe. In an alternative method a tube of the polymer is irradiated before use and advantage is taken of its resulting increased temperature resistance to tension draw it at a temperature above the normal crystalline melting point. This tension drawing reduces the diameter of the tube so that it can be cooled and placed inside the rigid pipe, and then reheated to allow it to expand into contact with the walls of the pipe. Instead of tension drawing, the plastic tube could be drawn through a tapering die to achieve the initial reduction in diameter. Whilst the invention is particularly suitable for lining metal pipes it is also equally applicable to the lining of pipes of rigid thermosetting plastic, or of fibre glass, glass or other rigid materials. The irradiation dose is selected to suit the plastic being used and is arranged to be sufficient to enhance its temperature resistance in a known manner, whilst not being sufficient to cause degradation and loss of mechanical properties. It will be understood that the invention is applicable only to those polymers which are cross-linked by irradiation. Dependent upon the plastic used, the irradiation dose may be anywhere in the region from 0·1 to 50 Megarads. Examples are given of methods of lining pipes or vessels according to the invention.—*September* 16, 1959.

FLUID SEALS

820,026. May 17, 1957.—Fluid Seals for Use between Relatively Movable Parts, Crane Packing, Ltd., Berwick Avenue, Slough, Buckinghamshire. (*Inventor: Samuel Clifford Walter Wilkinson.*)

The object of the invention is to provide an emergency or supplementary seal, for use in combination with main sealing means between relatively movable parts, the emergency seal being normally ineffective for sealing purposes but adapted as occasion requires, such as in an emergency, to be brought into action to serve as a main seal, so that the main sealing means may be dismantled or otherwise serviced without the need of removal of fluid from the interior of equipment. The drawing we reproduce shows a longitudinal section of one embodiment,



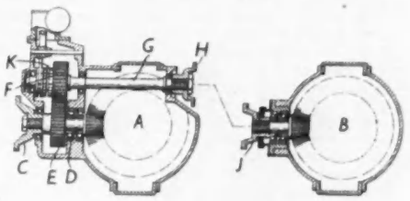
No. 820,026

in which the emergency or supplementary seal comprises a hollow elastic sealing element directly mounted in a recess in a pump housing. The emergency sealing device is inflatable and is applied immediately on the inside of the main sealing means, such as a mechanical seal or, as shown, resilient packing *A* accommodated in a gland through which passes a shaft. The emergency sealing device comprises a flexible or elastic U-shaped ring *B* which can be inflated with liquid or by air pressure so that it is forced into contact with the shaft thus forming a temporary seal. The ring is internally supported by a split support ring and retained in a recess in the back of the gland by a securing ring *C* held by bolts. When the equipment upon which this emergency sealing device is used is operating normally, the bore of the ring is of larger diameter than the diameter of the shaft, the clearance being a generous one to avoid wear. In an emergency, fluid pressure is applied through the connection *D*, to bring the bore of the ring into contact with the shaft, thus effecting the seal. In this condition, fluids within the equipment will be kept away from the packing or main seal, so that the necessary repair work or adjustments can be carried out.—*September* 16, 1959.

MOTOR VEHICLES

820,103. October 30, 1957.—Tandem Axle Arrangement, Eaton Axles, Ltd., Victoria Road, Great Sankey, Warrington, Lancashire.

This invention relates to a tandem axle arrangement on a vehicle wherein one axle is driven from the engine propeller shaft and another axle is selectively driven in series by gearing from the first axle. It is an object of this invention to provide a device which combines the advantages of a single axle drive with those of a tandem axle drive. One of the axles is driven at all times by the vehicle propeller shaft. The second axle is selectively connected in series with the first so that when the axles are so connected, each is driven at the same speed by the engine. A clutch is provided between the first and second axles which automatically disengages above a predetermined speed so that only one of the axles is driven by the engine when a predetermined speed is reached. When the speed falls below this speed, the clutch automatically engages and provides positive two-axle drive. The arrangement comprises axles *A* and *B*. The axle *A* is driven



No. 820,103

from the engine propeller shaft through a flange *C* a shaft *D*, and a bevel gear. A pinion on shaft *D* has a gear *E* secured to it which meshes with a gear *F* which is free to rotate on a shaft *G*. A universal joint companion flange *H* splined to the shaft *G* is connected by a propeller shaft to the companion flange *J* of the axle *B*. A clutch *K* operated by a conventional shifting means can be used to couple or disengage the drive between the two axles. A governer operated mechanism to automatically couple and disengage the drive between the two axles in accordance with vehicle speed is described in the specification.—*September* 16, 1959.

DIECASTING MACHINES

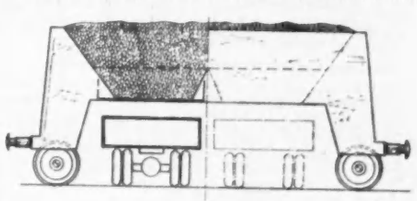
820,572. May 27, 1957.—Diecasting Machines, E.M.B. Company, Ltd., Moor Street, West Bromwich, Stafford. (*Inventor: George Norman Cadbury.*)

This invention relates to cold chamber diecasting machines and consists of a method whereby metal ingots, each of sufficient size to form a single casting, are first passed through a preliminary heater, and subsequently fed singly to a ladle in which the ingot is melted by a high-frequency current. When melted the content of the ladle is discharged automatically to the feed cylinder from which the molten metal is transferred to the die by a plunger in the usual manner. The invention is stated to be particularly advantageous for use in the production of castings from aluminium or aluminium alloys, magnesium, copper, or copper alloys, and where necessary, the fusion may be effected in an inert atmosphere.—*September* 23, 1959.

MATERIALS HANDLING

820,389. March 28, 1957.—Hoppered Railway Wagon, Richard Talbot, Waggonfabrik Talbot, Aachen, Germany.

The invention relates to a self-discharging hoppered railway wagon with the hopper opening or openings so high above the rails that a lorry or a narrow-gauge rail truck 2m high can be driven underneath for the



No. 820,389

load, or part of it, to be discharged. The accompanying drawing illustrates one embodiment of the invention.—*September* 16, 1959.

METALLURGY

820,357. February 18, 1958.—Manufacture of Steel, Centre National de Recherches Metallurgiques, rue du Val-Benoit, Liège, Belgium.

The invention relates to the manufacture of steel by refining of pig iron in a bottom-blown converter. In the known process of refining pig iron in the converter, the phosphorus of the bath is removed by oxidation and the phosphoric anhydride so formed is absorbed by a basic slag forming agent which is added to the bath. The injection in the metallic bath of the dephosphorising agent finely divided and carried by the blast blown through the bottom of the converter is well known, but in this process the bath generally absorbs an important quantity of nitrogen. An object of the invention is to provide a process

which enables this disadvantage to be avoided. According to the invention, the finely divided dephosphorising agent is injected through the bottom of the converter carried by an oxidising gas or gaseous mixture which is commercially free of nitrogen. By the process it is possible to inject the dephosphorising agent without risk of increasing the nitrogen content of the bath. The dephosphorising agent injected comprises one or more basic agents and, if necessary, fluxing agents. Basic agents and/or fluxing agents may be wholly or partly replaced by premanufactured slags. The agents may be either lime or any other basic oxide or carbonate, or a mixture of these. The fluxing agents may be either fluorspar, or metallic oxides, such as iron or manganese oxides, or any other agent able to lower the melting point of the basic agents or a mixture of these fluxing agents. The oxidising nitrogen-free gas of commercial quality or gaseous mixture which carries the dephosphorising agent and which is blown through the bottom of the converter, may be either a mixture of oxygen and carbon dioxide or a mixture of oxygen and steam, or any other oxidising nitrogen-free gas of commercial quality or gaseous mixture. An advantageous form of the process according to the invention consists in blowing through the bottom of the converter the finely divided dephosphorising agent carried by a nitrogen-free gas of commercial quality or gaseous mixture, while during the whole or a part of the operation commercially pure oxygen is injected on to and/or in the bath from the top of the converter.—*September* 16, 1959.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., Oct. 12.—BOURNEMOUTH AND DISTRICT BRANCH: Grand Hotel, Firvale Road, Bournemouth, "Modern Aspects of Electrical Connections." Dr. Rowland, 8 p.m. ★ CENTRAL LONDON BRANCH: White Hall Hotel, Bloomsbury Square, London, W.C.1, "W.D. Gamma Interlock Coke-Oven Installations," F. J. Burridge, 7.15 p.m. ★ NORTH WEST LONDON BRANCH: Century Hotel, Wembley, "Revision of British Standards and Effect on Electric Motor Performance," F. T. Bartho, 8.15 p.m.

Tues., Oct. 13.—CHESTER AND DISTRICT BRANCH: Westminster Hotel, City Road, Chester, "Silicones and their Application in Industry." D. R. Goddard, 7.45 p.m. ★ GLASGOW BRANCH: Kenilworth Hotel, Queen's Street, Glasgow, C.1, "Underwater Photography," 8 p.m. ★ PORTSMOUTH AND DISTRICT BRANCH: Offices of the Ministry of Labour and National Service, Lake Road, Portsmouth, "Flameproof Installations," 7.30 p.m. ★ SOUTH EAST LONDON BRANCH: Eltham Green School, Queenscroft Road, Eltham, London, S.E.9, "The Development of Motor-Control Centres." P. Wyer, 7.45 p.m. ★ SOUTH WALES BRANCH: South Wales Institute of Engineers, Park Place, Cardiff, "Measuring Instruments." H. W. A. Smith, 7.30 p.m. ★ YORK BRANCH: Georgian House, Blossom Street, York, "Latest Development in 'Pyro' Cables." W. Cameron, 7.30 p.m.

Wed., Oct. 14.—BIRMINGHAM BRANCH: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "The National Inspection Council for Electrical Installation Contracting." E. W. Roper, 7.30 p.m. ★ LUTON BRANCH: College of Technology, Park Square, Luton, "Artificial Satellites and the International Geophysical Year," 8.15 p.m.

Thurs., Oct. 15.—OXFORD AND DISTRICTS BRANCH: Reactor School, A.E.R.E., Harwell, "Telecommunication," 5.45 p.m. ★ WEST KENT BRANCH: Visit to *Daily Mirror*, London, 9.30 a.m.

Sat., Oct. 17.—YORK BRANCH: Visit to Northern Dairies, Holme-on-Spalding Moor, 2.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Oct. 14.—LONDON STUDENT SECTION: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "The Use of Transistors in Communication and Control," E. Wolfendale, 6.30 p.m. ★ NORTH-EASTERN SECTION: Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne, "True Motion Radar," A. Harrison, 6 p.m.

CHEMICAL SOCIETY

Thurs., Oct. 15.—Burlington House, Piccadilly, London, W.1, Niels Bjerrum Memorial Lecture by E. A. Guggenheim, 7.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Tues., Oct. 13.—NORTHERN REGION: Grand Hotel, Sheffield, "A Brains Trust on Furnace Operation," 10.30 a.m.

DIESEL ENGINEERS AND USERS' ASSOCIATION

Thurs., Oct. 15.—Memorial Building, Institute of Marine Engineers, 76, Mark Lane, London, E.C.3, Annual General Meeting; Report for 1958; and "Bearings for Diesel Engines," P. P. Loue, 2 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Oct. 13.—Memorial Building, 76, Mark Lane, London, E.C.3, "Centrifugal Purification of Oils," M. E. O'K. Trowbridge, 5.30 p.m.

Wed., Oct. 14.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "The Survey of Marine Machinery," G. J. Thomas, 7.30 p.m.

Mon., Oct. 19.—SOUTH WALES SECTION: South Wales Institute of Engineers, Park Place, Cardiff, "Cavitation," E. E. Williams, 7 p.m. ★ WEST OF ENGLAND SECTION: Small Engineering Lecture Theatre, The University, University Walk, Bristol, 8, "Marine Machinery Breakdowns," J. H. Milton, 7.30 p.m.

INSTITUTE OF METAL FINISHING

Wed., Oct. 14.—ORGANIC FINISHING GROUP: British Institute of Management, 80, Fetter Lane, London, E.C.4, "Some Notes on American Organic Finishing Practice," W. Stein and A. A. B. Harvey, 6.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

To-day, Oct. 9.—SOUTH WALES CENTRE: South Wales Institute of Engineers, Park Place, Cardiff, "Oil Additives," A. Towle, 7.15 p.m.

Mon., Oct. 12.—WEST REGIONAL CENTRE: Liverpool Architectural Society's Rooms, Bluecoat Chambers, School Lane, Liverpool, 1, "The Design of Radial-Flow Turbochargers and their Application to Road Transport," E. Kellett, 7.30 p.m.

Tues., Oct. 13.—NORTH REGIONAL CENTRE: Commercial Hotel, Accrington, "Research and Test Procedure in Connection with Automotive Fuels," L. P. F. Drake, 7.30 p.m.

Wed., Oct. 14.—SOUTHERN CENTRE: Wooden Bridge Hotel, Guildford, Surrey, "Problems in Developing the High-Speed Diesel Engine," B. W. Millington, 7.30 p.m. ★ SOUTH EASTERN GROUP: Wig and Gown Hotel, Maidstone, "Research on the Testing and Performance of Commercial Vehicle Brakes," H. J. Starks, 7.30 p.m.

Thurs., Oct. 15.—METROPOLITAN AREA: Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, Fourteenth Annual General Meeting; Films, "Major Road Ahead," and Coupe des Alpes," 6.30 p.m. ★ YORKSHIRE CENTRE: Great Northern Hotel, Wellington Street, Leeds, 1, "Brake Testing," 7.30 p.m. ★ SOUTH WESTERN GROUP: Exeter City Fire Brigade Premises, Exeter, "SIF Bronze and Its Action," 7.30 p.m.

Mon., Oct. 19.—SCOTTISH CENTRE: North British Hotel, Princes Street, Edinburgh, "Servicing of Electrical Equipment," J. H. Stoneman, 7.30 p.m.

Tues., Oct. 20.—NORTH EASTERN CENTRE: Three Tuns Hotel, Durham City, "Current Developments in Tyres and Steering Geometry," J. L. Johnson, 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Oct. 13.—Great George Street, Westminster, London, S.W.1, "The Requirements for Airfield Pavement Surfaces." G. S. Cooper; "Asphalt Surfacing for Airfields," A. W. Attwooll and D. C. Broome, and "The Suitability of Concrete for Airfield Runways," A. W. Hill, 5.30 p.m.

Thurs., Oct. 15.—Great George Street, Westminster, London, S.W.1, Informal Discussion on "Water Excluding Structures," L. R. Creasy and L. Scott White, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Oct. 9.—NORTH STAFFORDSHIRE SUB-CENTRE: Duncan Hall, Stone, Chairman's Address, "The Use of Information in Control Systems," A. Asbury, 7 p.m. Ordinary Meeting: Savoy Place, London, W.C.2, President's Inaugural Address, Sir Willis Jackson, 5.30 p.m.

Mon., Oct. 12.—INFORMAL MEETING: Savoy Place, London, W.C.2, Discussion on "Is the Present Pace of Electrical Progress Good for the Community?" opened by the President, 5.30 p.m. ★ NORTH-EASTERN CENTRE: Neville Hall, Westgate Road, Newcastle upon Tyne, Chairman's Address, H. Watson-Jones, 6.15 p.m. ★ SOUTH MIDLAND CENTRE: Winter Gardens, Malvern, "The Basic Physics of Thermonuclear Processes," D. R. Chick, 7 p.m. ★ SOUTH MIDLAND SUPPLY AND UTILISATION GROUP: College of Technology, Gosta Green, Birmingham, "The Provision of Adequate Electrical Installations in Buildings"—(*a*) "Commercial Buildings," E. E. Jacobi, and (*b*) "Small Industrial Premises." J. A. Sharp, 6 p.m. ★ WESTERN CENTRE: South Wales Institute of Engineers, Cardiff, Chairman's Address, H. Jackson, 5 p.m.

Tues., Oct. 13.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, "The Relationship of Physical Mechanisms to Psychological Processes." A. Tustin, 5.30 p.m. ★ CAMBRIDGE ELECTRONICS AND COMMUNICATIONS GROUP: Cavendish Laboratory, Free School Lane, Cambridge, "New Amplifying Techniques." C. W. Oatley, 8 p.m. ★ NORTH MIDLAND CENTRE: H.Q. Mess, School of Signals, Catterick Camp, "Subscriber Trunk Dialling." D. A. Barron, 6.15 p.m. ★ NORTH-WESTERN UTILISATION GROUP: Engineers' Club, Albert Square, Manchester, Chairman's Address, W. E. G. Robinson, 6.15 p.m. ★ NORTHERN IRELAND CENTRE: David Keir Building, Queen's University, Stranmillis Road, Belfast, Chairman's Address, "The Provision of Commercial Television in Northern Ireland," T. S. Wylie, 6.30 p.m.

Wed., Oct. 14.—EDUCATION DISCUSSION CIRCLE: Savoy Place, London, W.C.2, Discussion on "Graduate Training in Industry," opened by W. H. Taylor, 6 p.m. ★ NORTH LANCASHIRE SUB-CENTRE: N.W. Electricity Board Demonstration Theatre, Friargate, Preston, Chairman's Address, O. Seymour, 7.15 p.m. RUGBY SUB-CENTRE: College of Technology and Arts, Rugby, Chairman's Address, W. J. Gibbs, 6.30 p.m.

Thurs., Oct. 15.—UTILISATION SECTION: Savoy Place, London, W.C.2, Chairman's Address, "The Electrical Engineer and the Heavy Chemical Industry," T. E. Houghton, 5.30 p.m. ★ NORTH SCOTLAND SUB-CENTRE: Electrical Engineering Department, Queen's College, Dundee, Chairman's Address, J. A. Aked, 7 p.m. ★ SOUTH-WESTERN SUB-CENTRE: Plymouth "B" Generating Station, Prince Rock, Plymouth, Chairman's Address, A. G. R. Bell, 3 p.m.

Fri., Oct. 16.—NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, Chairman's Address, J. A. Aked, 7.30 p.m.

Mon., Oct. 19.—EAST ANGLIAN SUB-CENTRE: Assembly House, Norwich, "A Review of Work Towards Nuclear Energy from Controlled Thermonuclear Reaction," D. W. Fry, 7.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: Royal Institution, Colquitt Street, Liverpool, "Subscriber Trunk Dialling." D. A. Barron, 6.30 p.m. ★ NORTH-EASTERN MEASUREMENT AND ELECTRONICS GROUP: Rutherford College of Technology, Newcastle upon Tyne, 1, Chairman's Address, C. C. Baxendale, 6.15 p.m. NORTH STAFFORDSHIRE SUB-CENTRE: Mechanics Institute, Crewe, "The Deltic Locomotive," C. M. Cock, 7 p.m. ★ READING DISTRICT MEETING: George Hotel, King Street, Reading, "The Provision of Adequate Installations in Small Houses and Flats," C. A. Belcher, 7.15 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., Oct. 12.—New Lecture Theatre, Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne, 1, "Planning a Modern Power Station," 7.15 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

To-day, Oct. 9.—NORTHERN BRANCH: County Hall, Kendal, "Skidding Resistance and the Polishing of Roadstones," D. J. Maclean, 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Sat., Oct. 10.—EASTERN GRADUATES' SECTION: Evening Visit to the Observatories, Cambridge.

Tues., Oct. 13.—COVENTRY A.D. CENTRE: Grosvenor Room, Hotel Leofric, Coventry, "Construction and Behaviour Characteristics of Tyres," T. French, 7.15 p.m. ★ NORTH-WESTERN GRADUATES' SECTION; Engineers' Club, Albert Square, Manchester, "Properties of Compressible Fluid Pressure Waves," W. A. Woods, 7 p.m. ★ LONDON GRADUATE SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, "Interior Space Problems in Vehicle Design," B. C. Mills, 6.30 p.m.

Wed., Oct. 14.—LUTON A.D. CENTRE: Royal Hotel, Mill Street, Luton, Repetition of A.D. Chairman's Address, 7.30 p.m. ★ ORDINARY MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, Presidential Address, "The Engineer, Life and Diesel Engines," H. Desmond Carter 6 p.m. ★ WESTERN GRADUATES' SECTION: Engineering Laboratories, The University, Bristol, "Study of Methods and Organisation for Expediting and Development of Prototype Aero-engines in the United States," N. Birch, 7.30 p.m.

Thurs., Oct. 15.—EASTERN GRADUATES' SECTION: Visit to M.G. Cars, Abingdon, 2.30 p.m. ★ EAST MIDLANDS GRADUATES' SECTION: Room C4, Engineering Buildings, The University, Nottingham, "The Design of General Services for an Engineering Laboratory," C. M. O'Neill, 7.15 p.m. ★ YORKSHIRE GRADUATES' SECTION: Hotel Metropole, Leeds, "Marking Devices," W. Edwards, 6.30 p.m.

Fri., Oct. 16.—SOUTHERN GRADUATES' SECTION: All-day visit and lecture, A.E.R.E., Harwell, Berks, 10 a.m.

Mon., Oct. 19.—DERBY A.D. CENTRE: Midland Hotel, Derby, "Some Considerations of the Lubrication of Free Piston Machinery," R. M. Hosie and G. M. Barratt, 7.15 p.m. ★ SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, Repetition of A.D. Chairman's Address, 7.30 p.m.

INSTITUTION OF NAVAL ARCHITECTS AND INSTITUTE OF MARINE ENGINEERS

Wed., Oct. 14.—SOUTHERN JOINT BRANCH: Technical College, St. Mary Street, Southampton, "Train and Car Ferries," J. P. Campbell, 7.30 p.m.

INSTITUTION OF PLANT ENGINEERS

To-day, Oct. 9.—BIRMINGHAM BRANCH: Hotel Leofric, Coventry, Open Forum, 7.30 p.m.

Tues., Oct. 13.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "New Developments in the Paint Industry," A. Walmsley and A. I. Seavall, 7.15 p.m.

Wed., Oct. 14.—DUNDEE BRANCH: Taypark Hotel, West Ferry Dundee, "Experience of Training Young Engineers for Marine Service," J. P. Bruce, 7.30 p.m. ★ E. MIDLANDS BRANCH: County Hotel, Theatre Square, Nottingham, "Jodrell Bank Radio Telescope." C. N. Kington, 7 p.m. ★ WESTERN BRANCH: Grand Hotel, Broad Street, Bristol, "Acoustics Insulation and its Thermal Properties," 7.15 p.m.

Thurs., Oct. 15.—BLACKBURN BRANCH: Castle Hotel, Blackburn, "Operational Research in the Steel Industry," G. D. Jordan, 7.30 p.m. ★ GLASGOW BRANCH: Scottish Building Centre, 425-427, Sauchiehall Street, Glasgow, "The Engineer's Approach to Non-Destructive Testing of Metals," H. Potter, 7.15 p.m.

Fri., Oct. 16.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, Mobile Plant Discussion Group, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Oct. 12.—1959 E. W. HANCOCK PAPER: Large Lecture Theatre, Engineering Faculty, The University, Bristol, "Human Relations in Industry," R. A. Banks, 6.30 p.m.

Tues., Oct. 13.—LONDON GRADUATE SECTION: 10, Chesterfield Street, Mayfair, London, W.1, "Properties and Application of Modern Precision Grinding Wheels," J. Manning and R. Barton, 7.15 p.m. ★ LUTON GRADUATE SECTION: Small Assembly Hall, Town Hall, Luton, "Effective Production Control Records," E. Read, 7.30 p.m.

Wed., Oct. 14.—PETERBOROUGH SECTION: Conference Room, Peterscourt, Peterborough, "Forum."—Panel: H. F. Adams, S. J. Bellamy, J. C. Player and Myron W. Rhotem, 7.30 p.m.

Thurs., Oct. 15.—WOLVERHAMPTON GRADUATES' SECTION: Evening Visit to S. J. Stanton and Sons, Hednesford, Staffs.

Mon., Oct. 19.—NORTH MIDLANDS REGION: Louis Room, St. James's Restaurant, St. James's Street, Derby, "What's New in Casting," A. Short, 7 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

To-day and Sat., Oct. 9 and 10.—The Palace Hotel, Southport, A two-day conference to discuss "Industrial Technical Organisation."

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Oct. 9.—WESTERN COUNTIES BRANCH: University Engineering Laboratories, Bristol, Chairman's Address, Peter Gardiner, Presentation of the Francis Memorial Prizes, 6 p.m.

Mon., Oct. 12.—SCOTTISH BRANCH: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Chairman's Address, Hugh Fraser, 7 p.m.

Wed., Oct. 14.—YORKSHIRE BRANCH: Metropole Hotel, Leeds, Chairman's Address, E. Lightfoot, 6.30 p.m.

Thurs., Oct. 15.—YORKSHIRE BRANCH: Royal Victoria Hotel, Sheffield, Chairman's Address, E. Lightfoot, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 9.—LONDON SECTION: Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Some Aspects of Industrial Space Heating." D. E. Edminson, 7 p.m. ★ NORTH WESTERN SECTION: Engineers' Club, Albert Square, Manchester, President's Address, 7.30 p.m.

Mon., Oct. 12.—SHEFFIELD SECTION: Livesey Clegg House, 44, Union Street, Sheffield, 1, Annual General Meeting and Chairman's Address, G. F. Taylor, 7.30 p.m.

Fri., Oct. 16.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1 "Programming a Computor," A. C. Quarterman, 7 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Thurs., Oct. 15.—Department of Metallurgy, The University, 146, Brownlow Hill, Liverpool, 3, Presidential Address, "The Production and Use of Steel Wire and Steel Wire Ropes," B. Ryan, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

To-day, Oct. 9.—Engineers' Club, Albert Square, Manchester, 2, Inaugural Address, M. Bentham, 6.45 p.m.

ROYAL STATISTICAL SOCIETY

Wed., Oct. 14.—GENERAL APPLICATIONS SECTION: Royal Institute of Public Health and Hygiene, 28, Portland Place, London, W.1, "The Study of Elections," H. C. Mackenzie, 6.15 p.m. ★ NORTH-EASTERN GROUP: Room C.39, The Percy Building, King's College, Newcastle upon Tyne, "Fractional Factorial Experimental Designs," G. A. Coutie, 7 p.m.

Thurs., Oct. 15.—BRISTOL GROUP: Library Room, The University, Bristol, 8, "Ways of Measuring Uncertainty," G. A. Barnard, 5.45 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., Oct. 14.—CORROSION GROUP: 14, Belgrave Square, London, S.W.1, "Fretting Corrosion," K. H. R. Wright, 6 p.m.

Thurs., Oct. 15.—CORROSION GROUP: 14, Belgrave Square, London, S.W.1, Joint Meeting with the Iron and Steel Institute, Discussion on "Sixth Report of the B.I.S.R.A. Corrosion Committee," 2 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

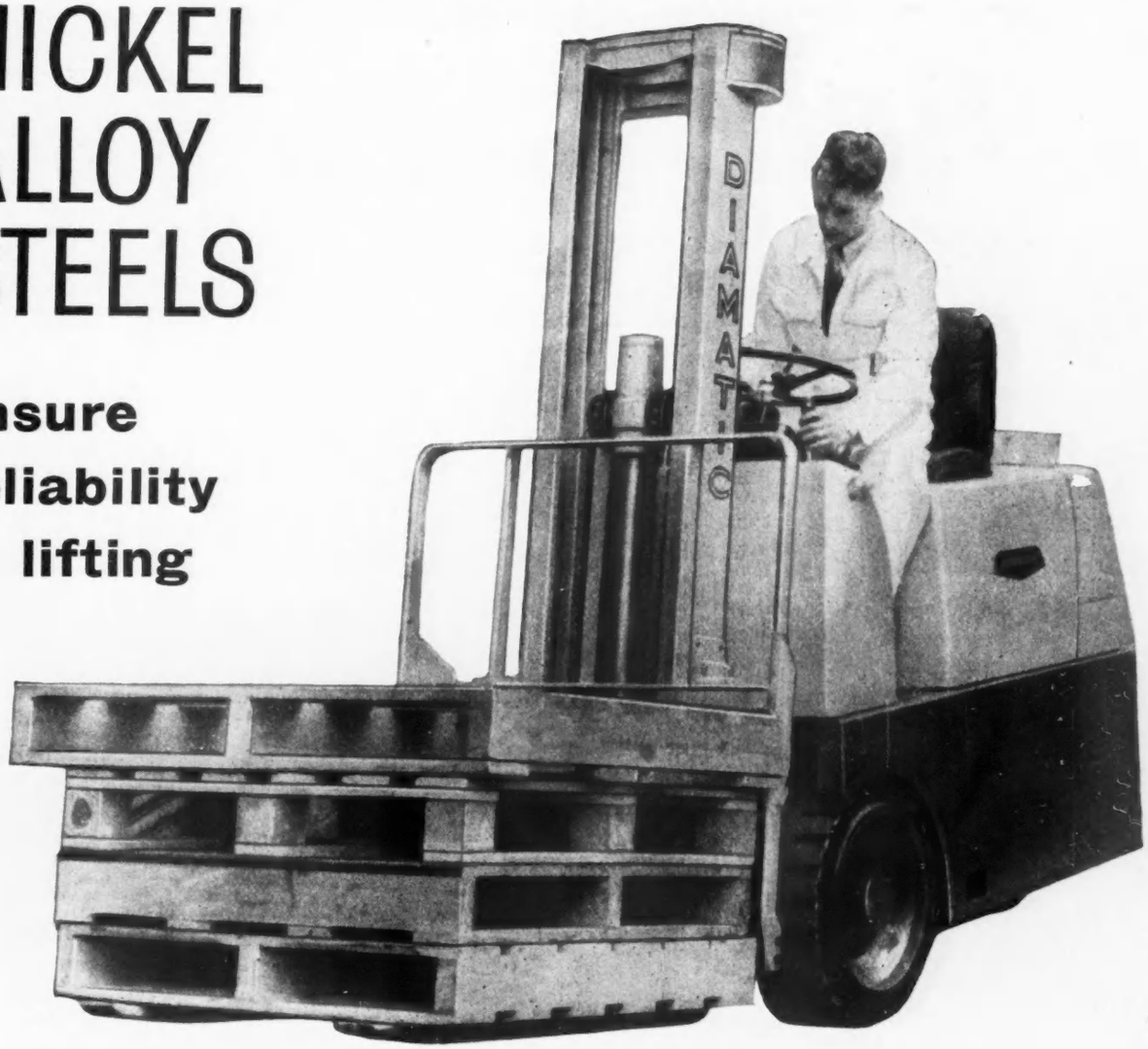
Wed., Oct. 14.—DATA PROCESSING SECTION: Manson House, 26, Portland Place, London, W.1, "An Automatic Analogue Computer for Missile Homing Investigations," J. G. Thomason, 6.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

Fri., Oct. 23.—Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Presidential Address, J. W. Todd, 6.45 p.m.

NICKEL ALLOY STEELS

ensure reliability in lifting



The fork lift truck, of which this Diac model is an advanced design, epitomises the transition of labour from man to machine.

This new unit, designed to achieve high operating speeds and quick servicing, incorporates various components made from eight nickel alloy steels, notably EN 33, the tried and proven 3 per cent nickel case-hardening steel long used for services where fatigue is a factor and wear resistance a requirement.

TYPICAL CORE MECHANICAL PROPERTIES OF

EN 33

ARE AS FOLLOWS:

SIZE	HEAT TREATMENT	MAXIMUM STRESS t.s.i.	ELONGATION per cent	IZOD ft. lb.
1⅛" dia	Oil quenched 860°C Water quenched 770°C.	56·3	21·5	83
3" dia	Oil quenched 860°C Water quenched 760°C.	47·2	20	92

The benefits to be gained from the more highly alloyed case-hardening nickel steels, such as EN 33, EN 34, EN 36 and EN 39 include ease of heat-treatment, minimisation of processing distortion, and general reliability.

Send for 'The Mechanical Properties of Nickel Alloy Steels' ▶

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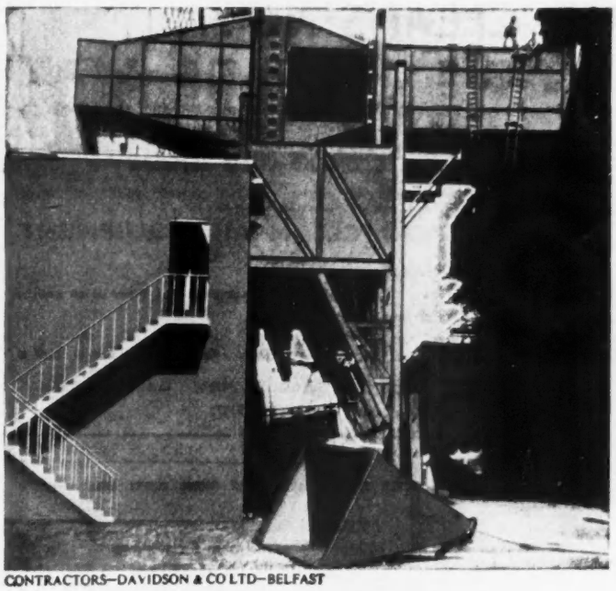

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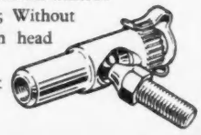

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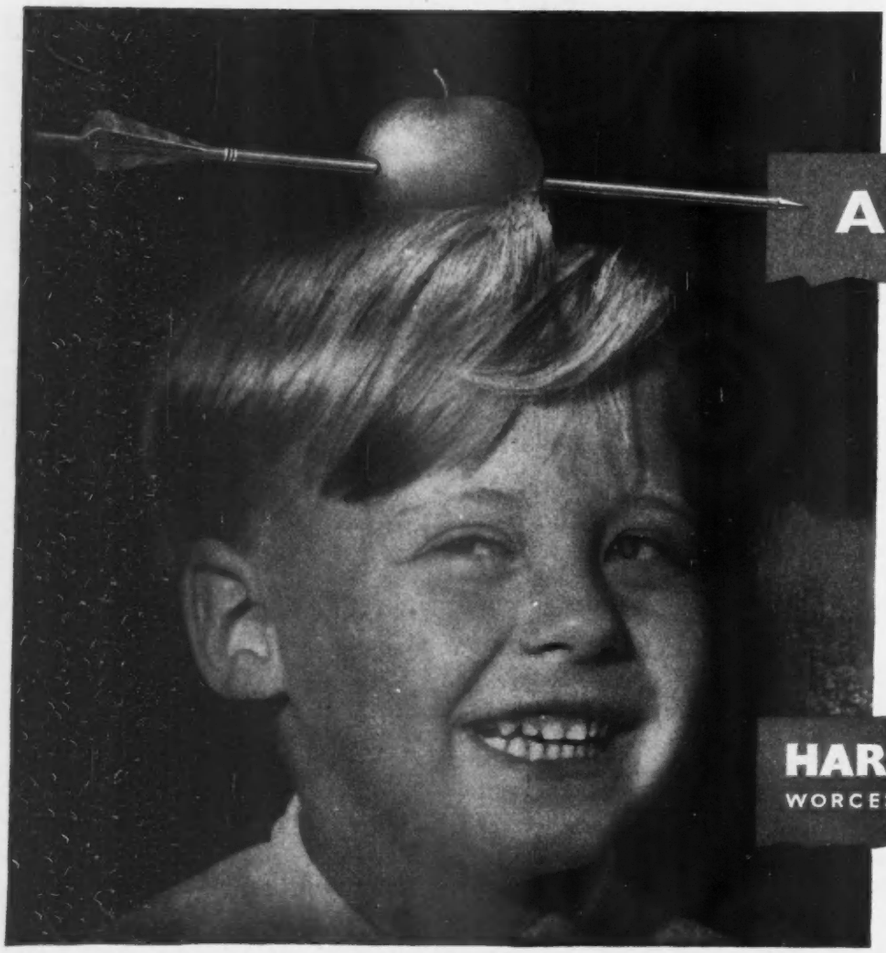

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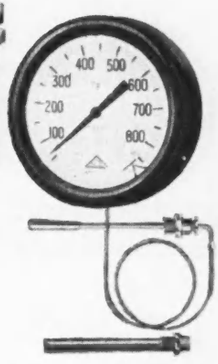

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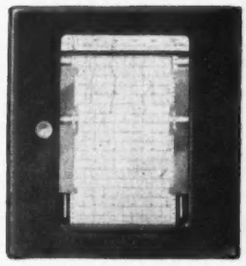

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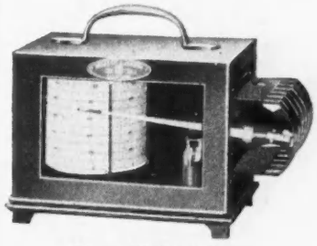

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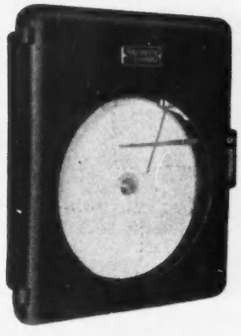

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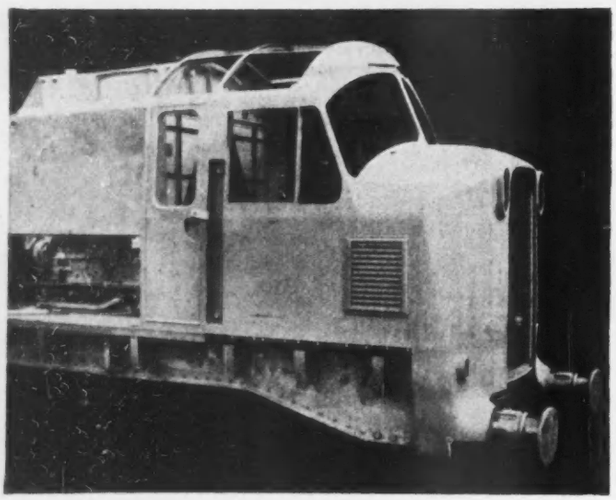

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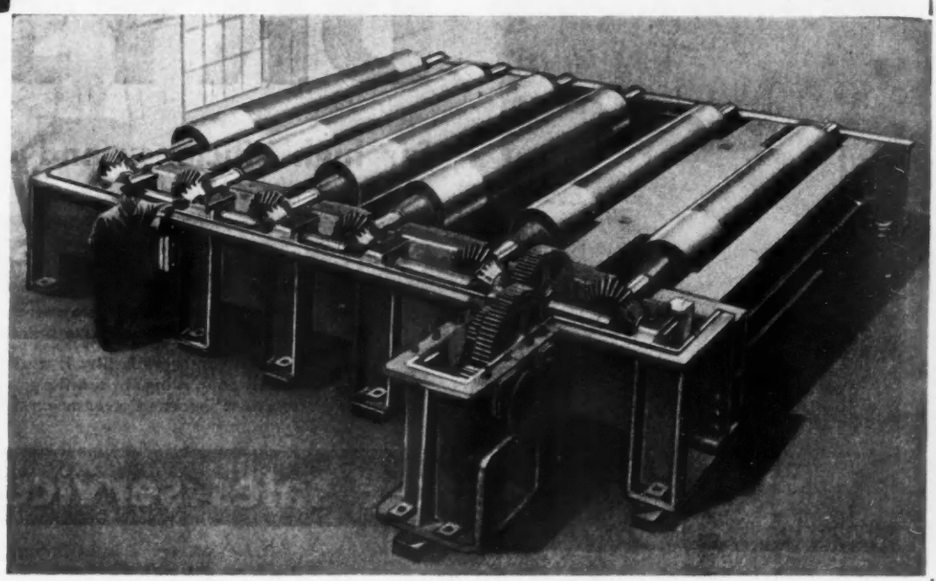

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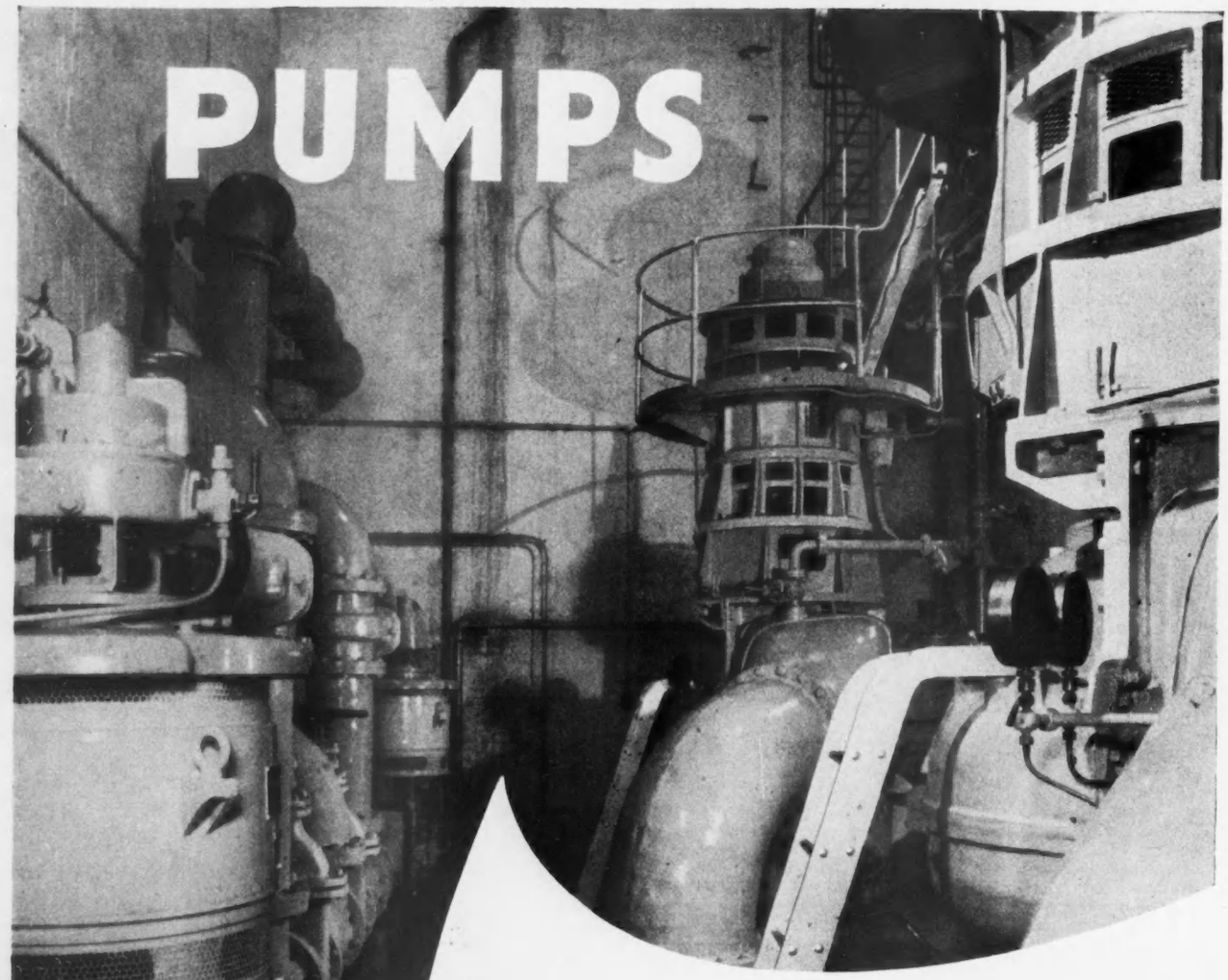

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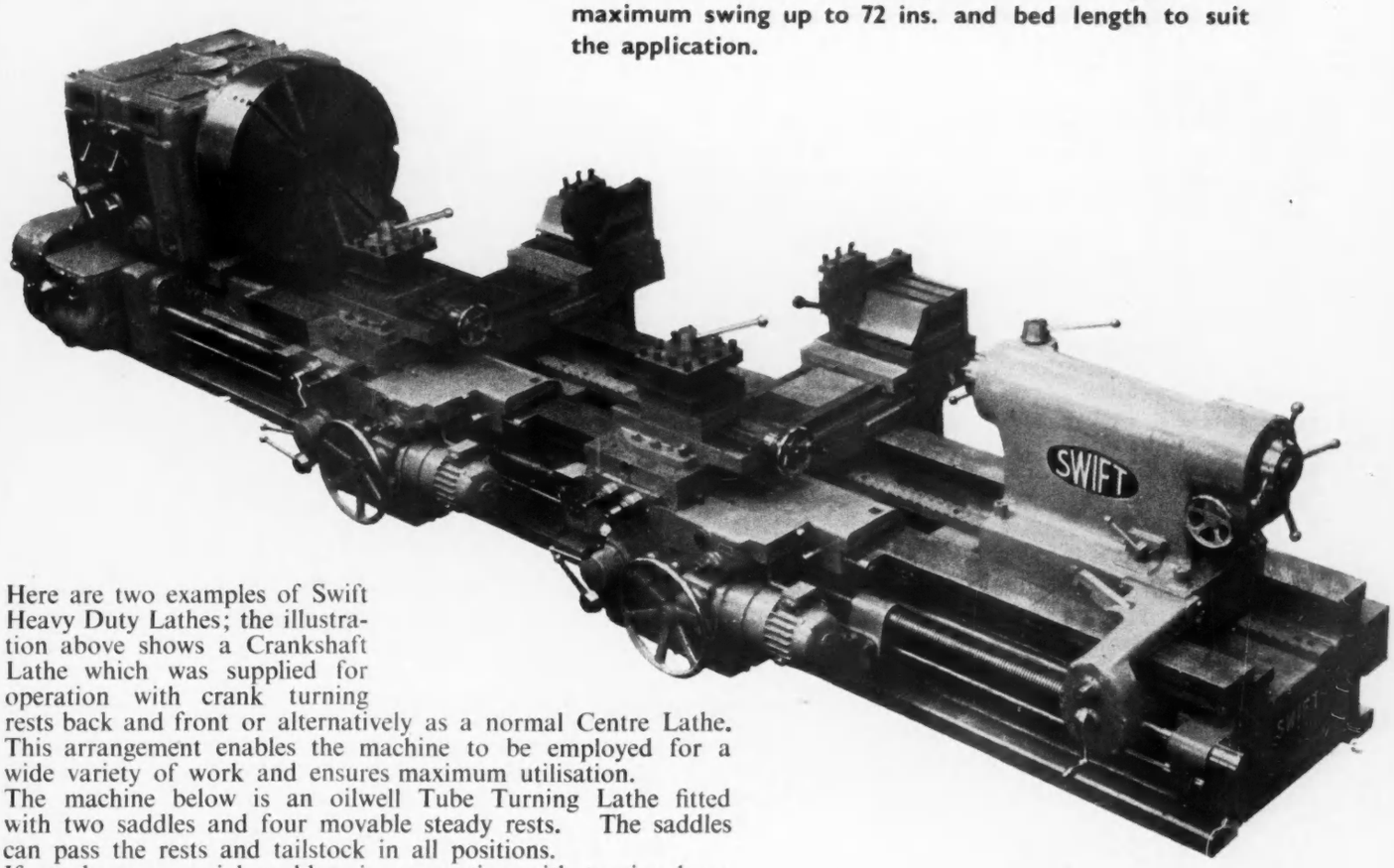

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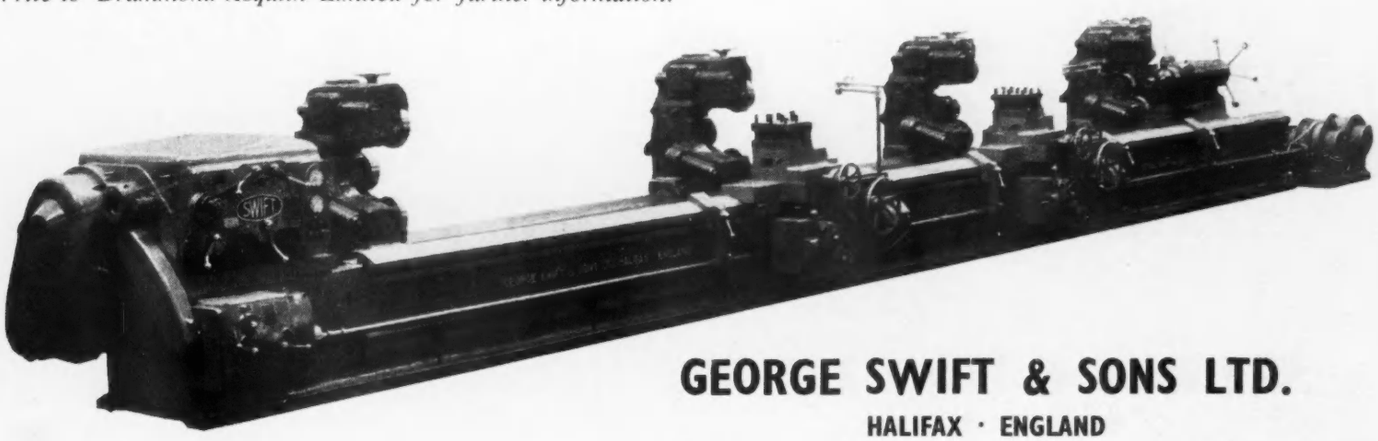

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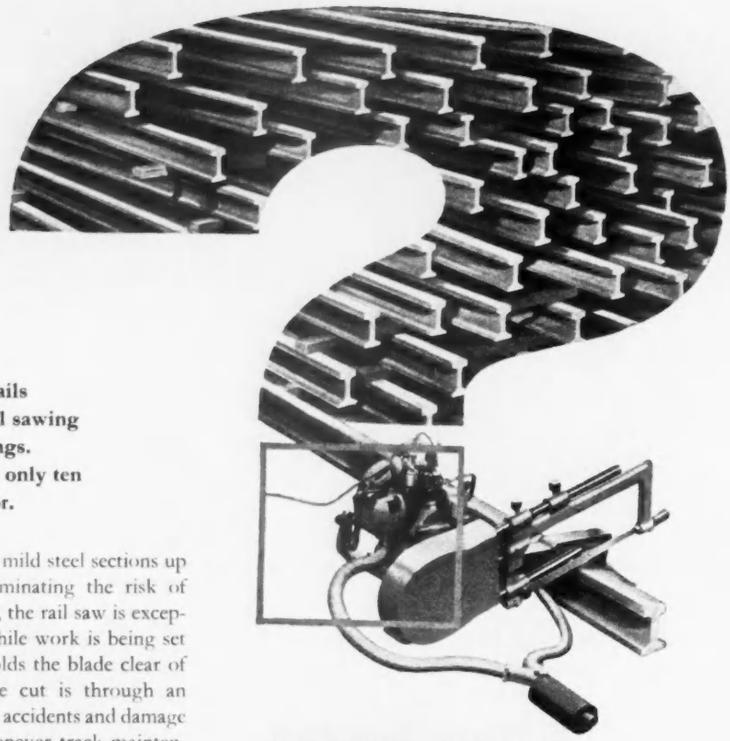

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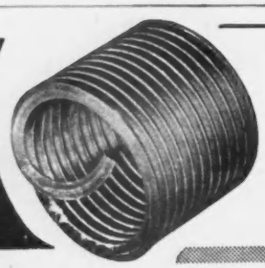

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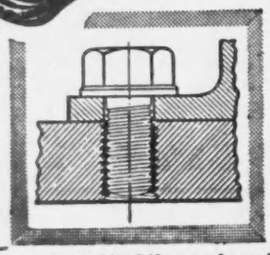

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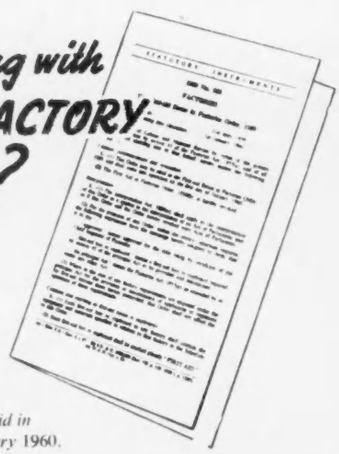

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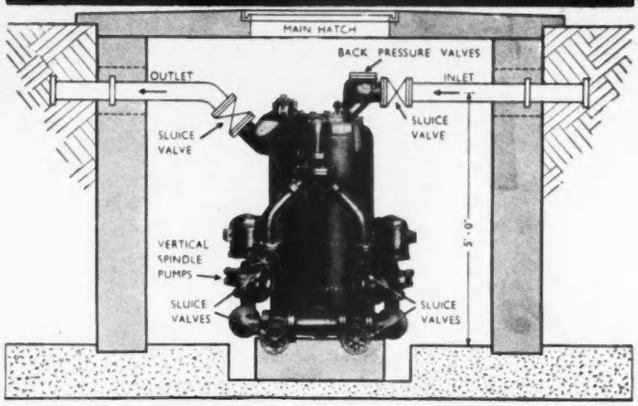

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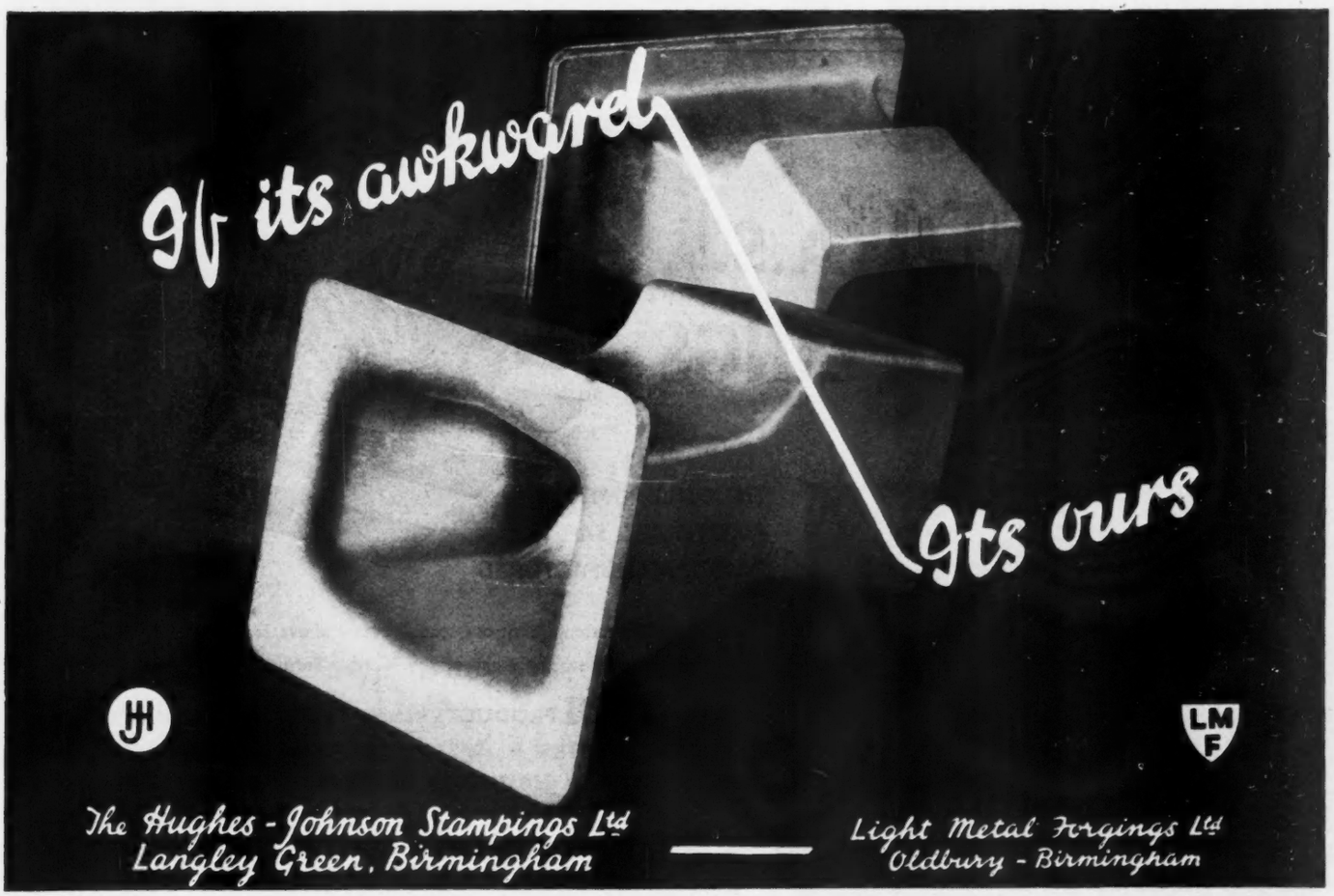

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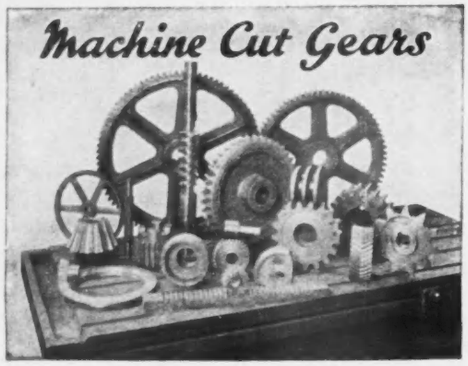

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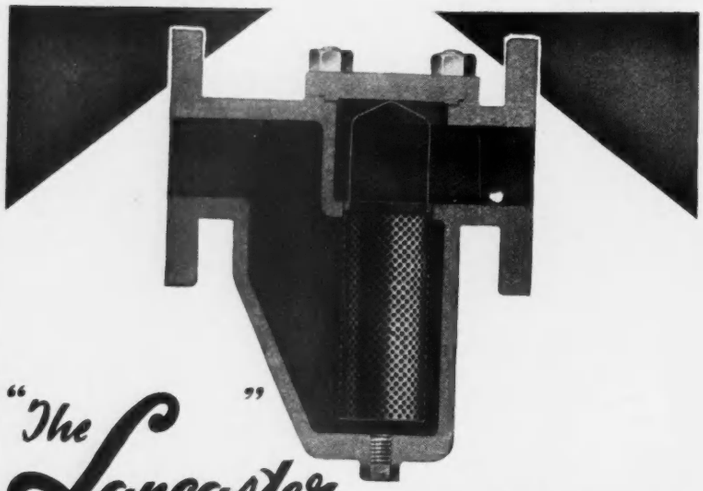

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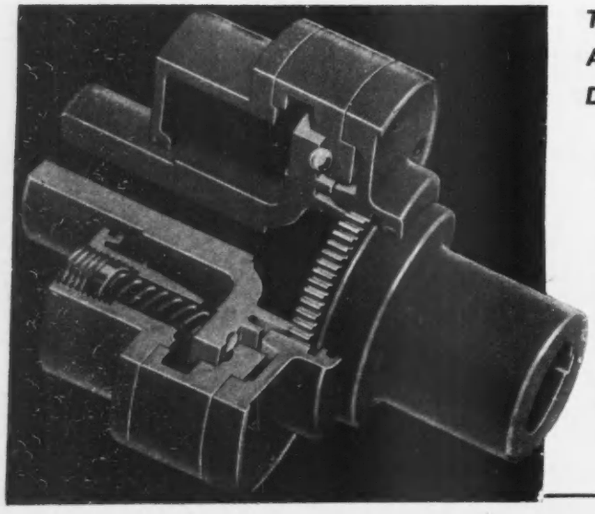

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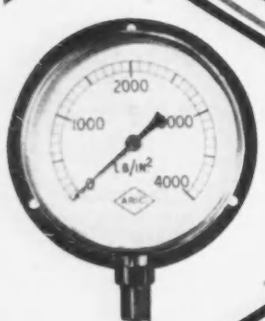

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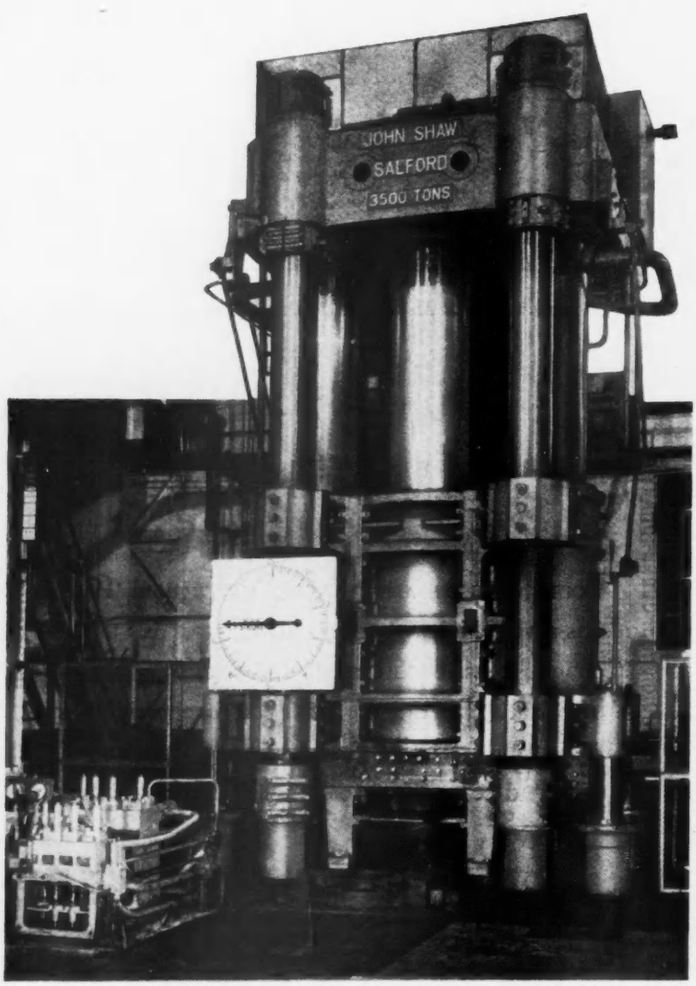

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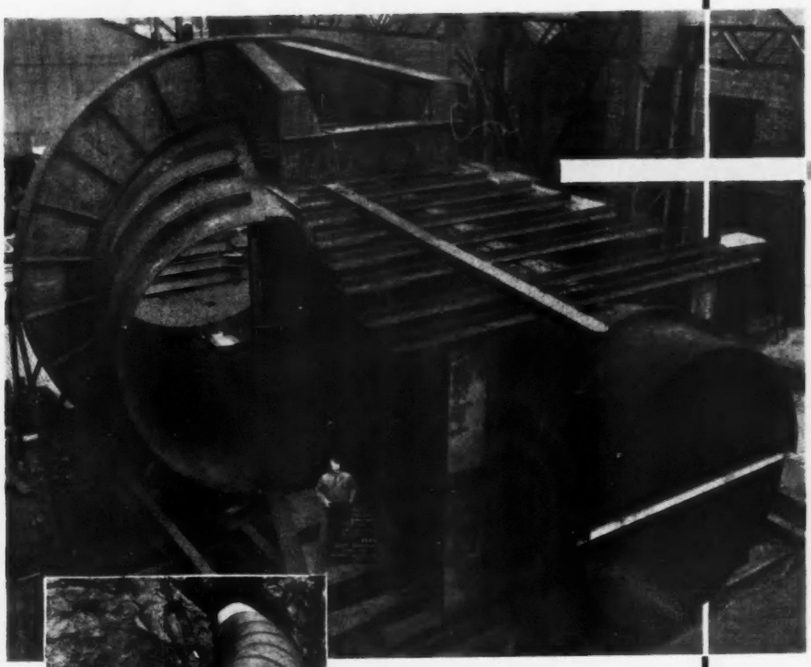

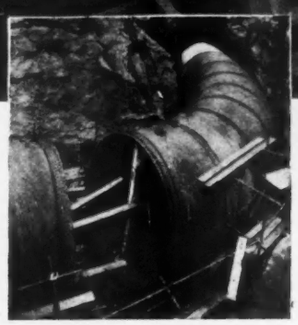

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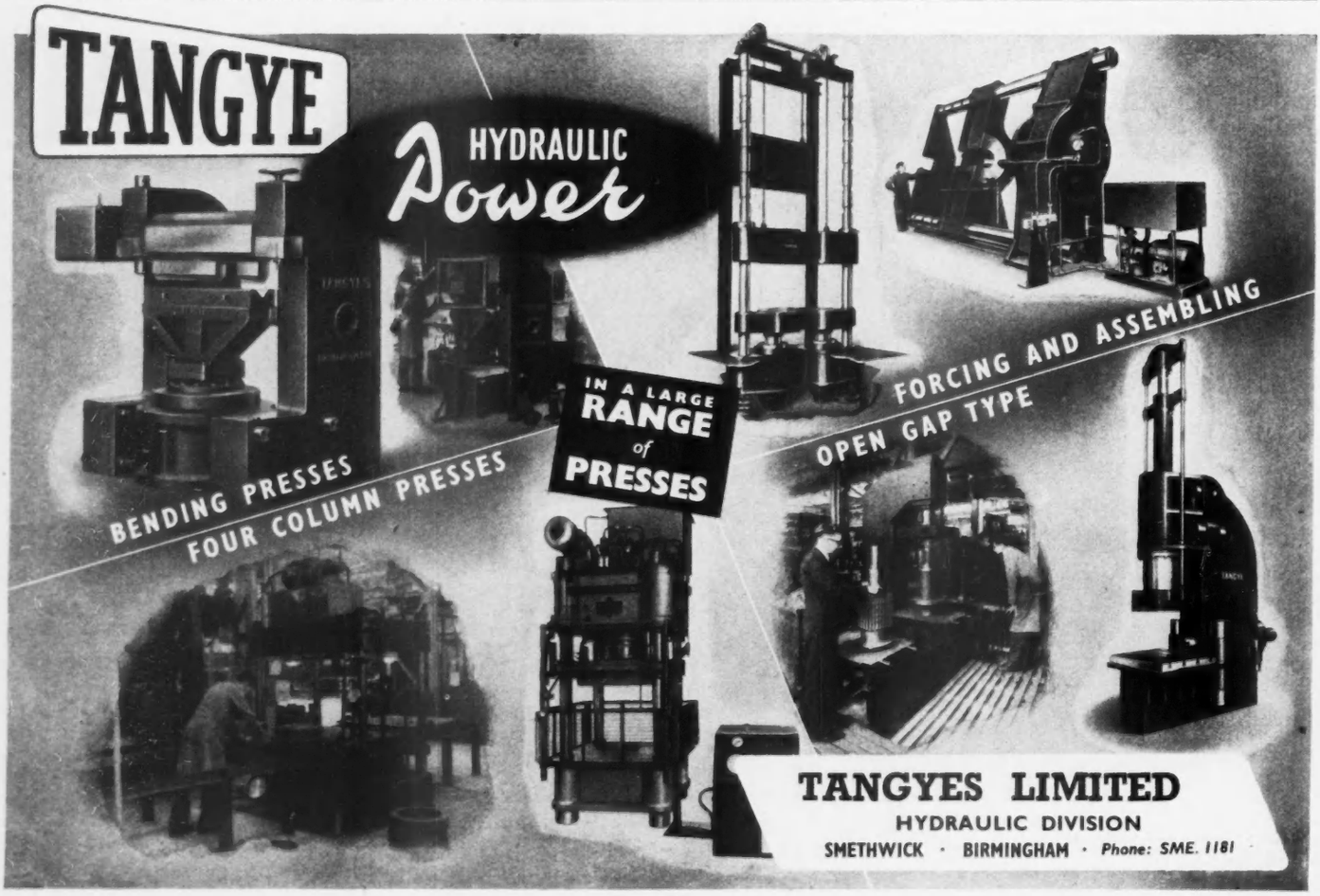

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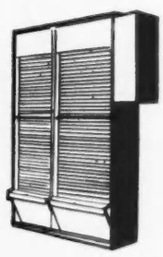

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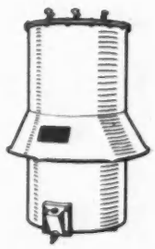

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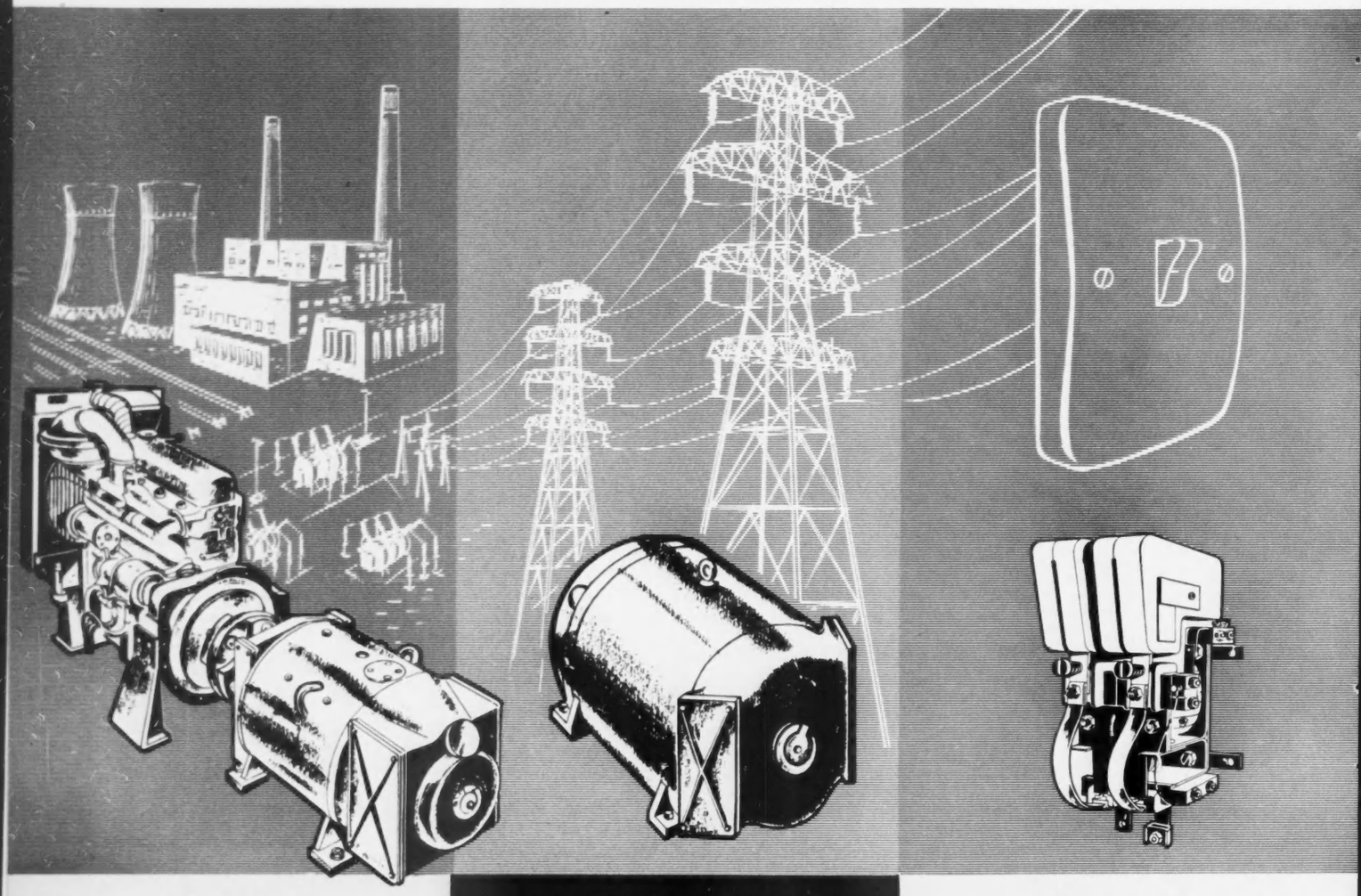

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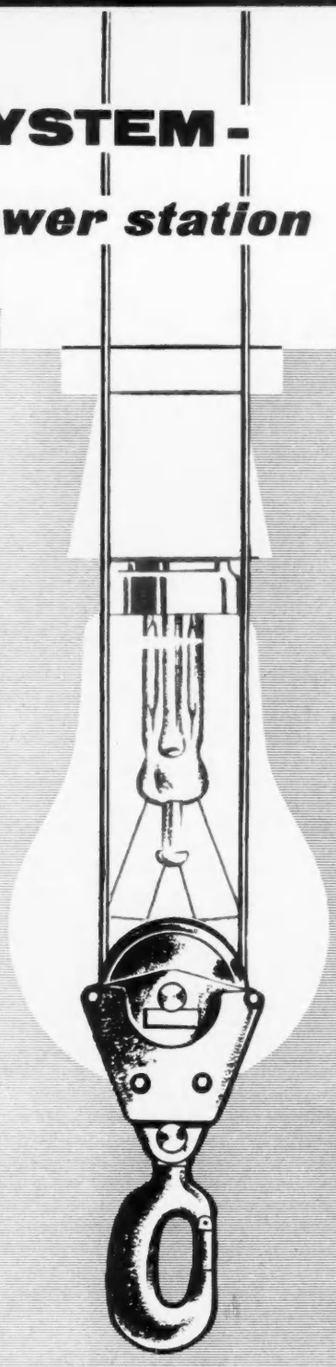

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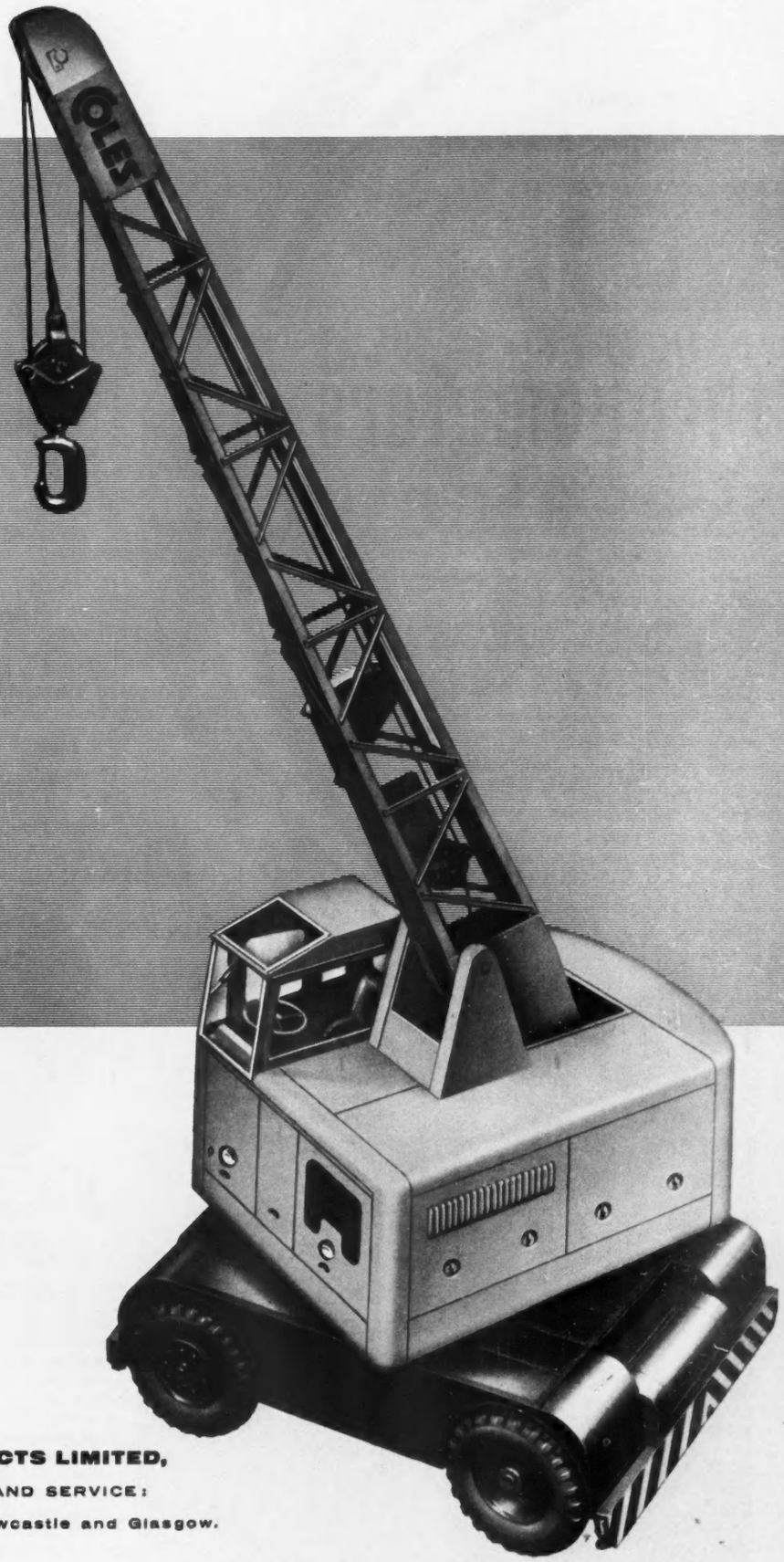

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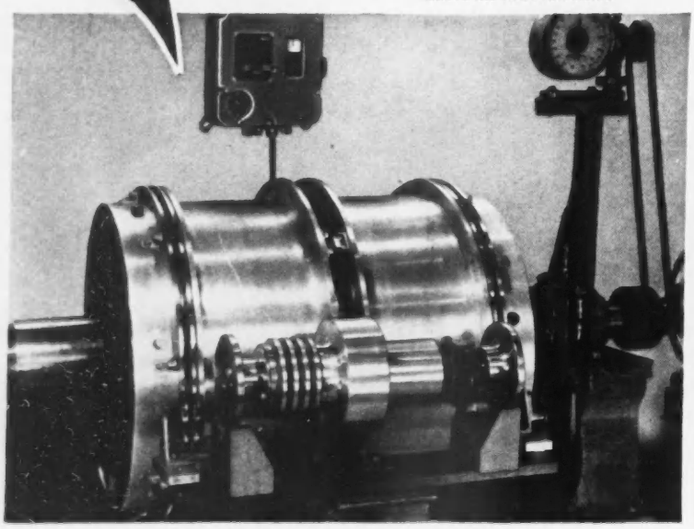

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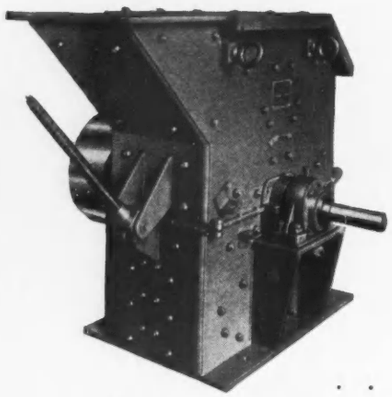

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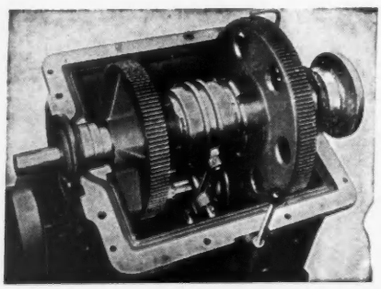

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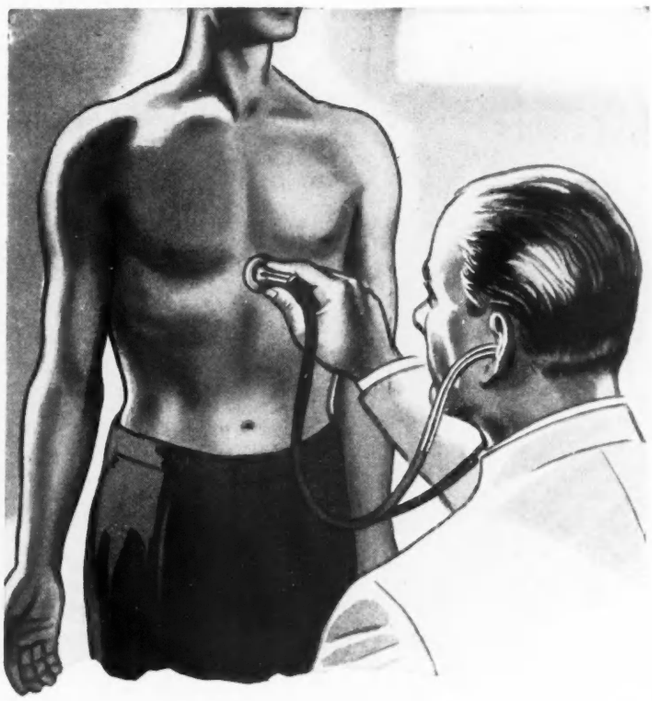

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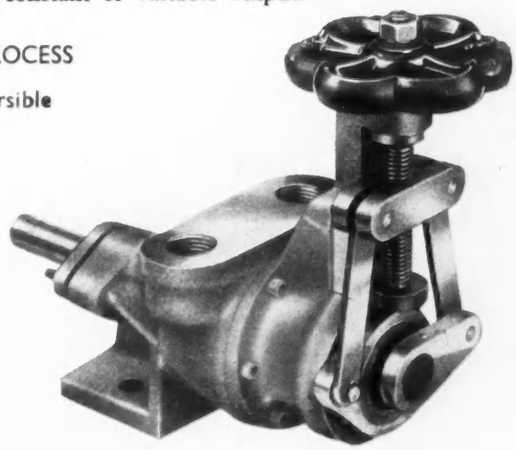

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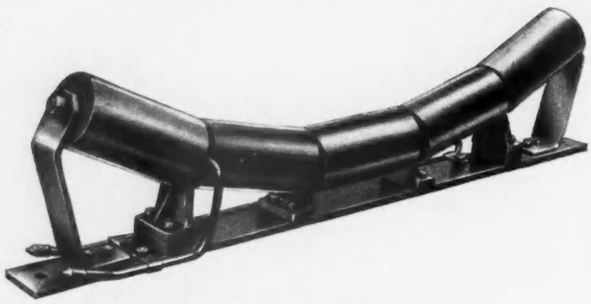

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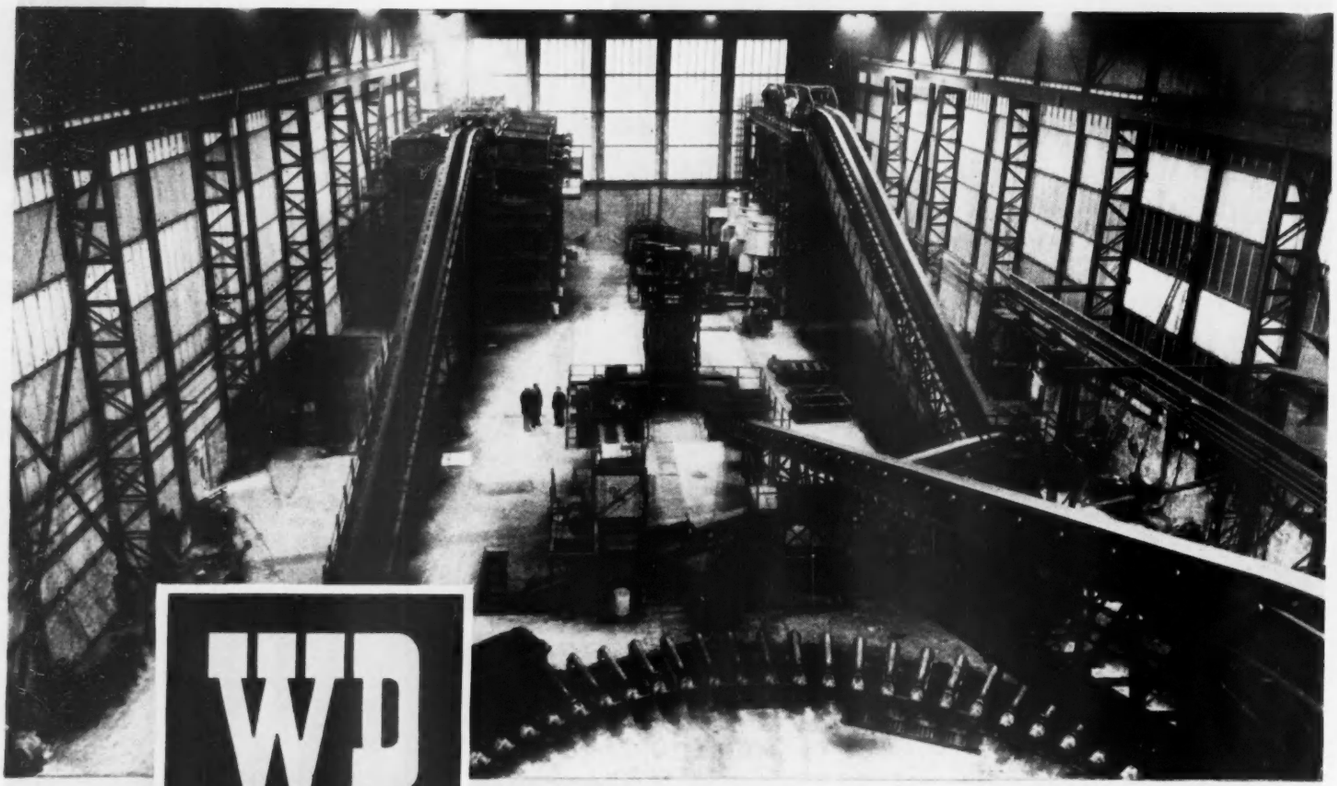

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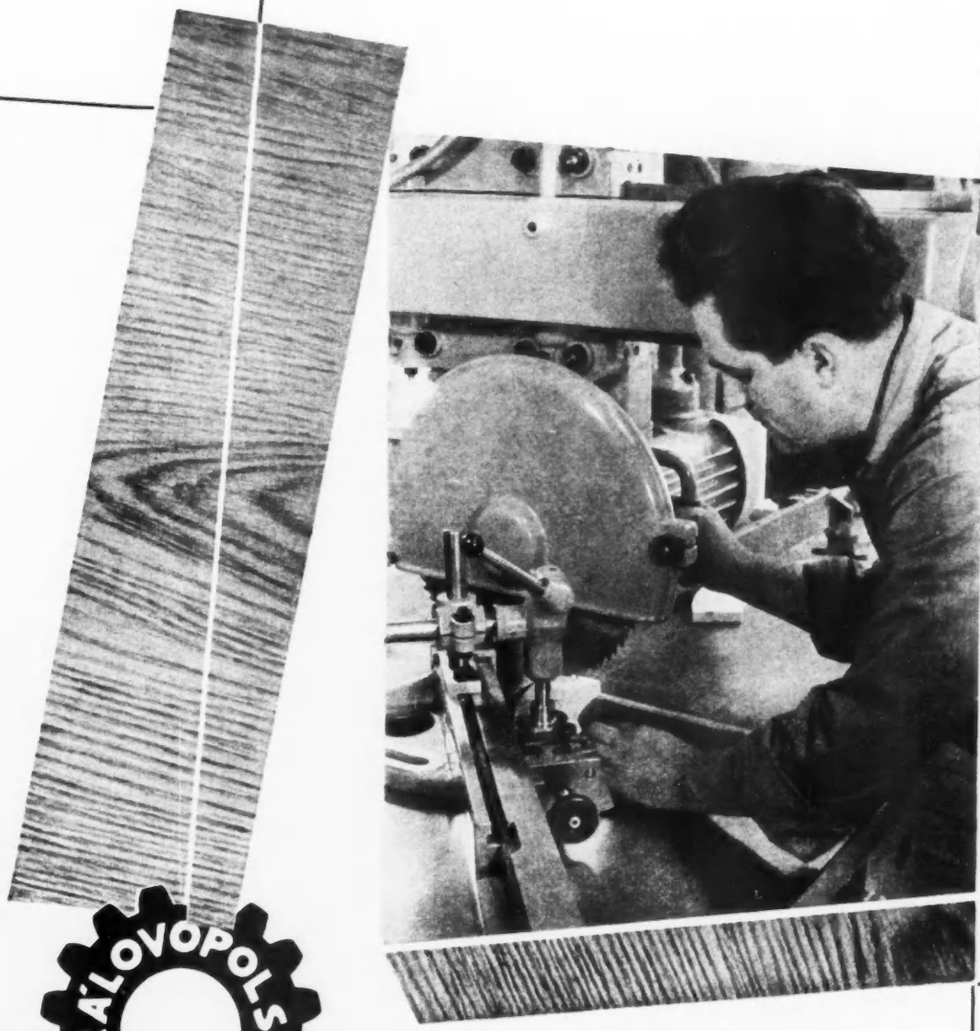

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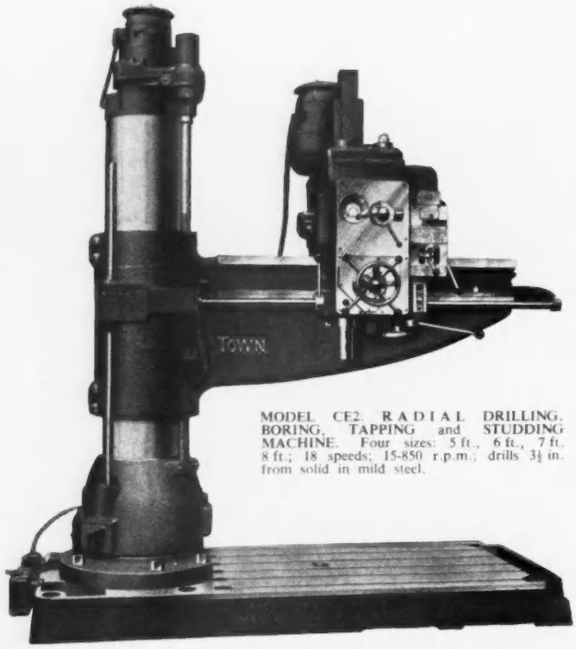

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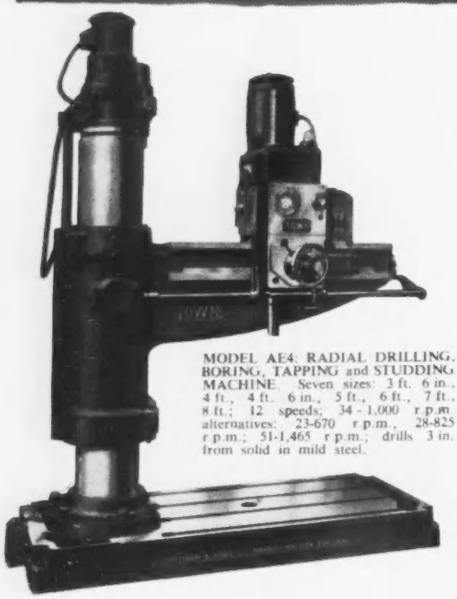

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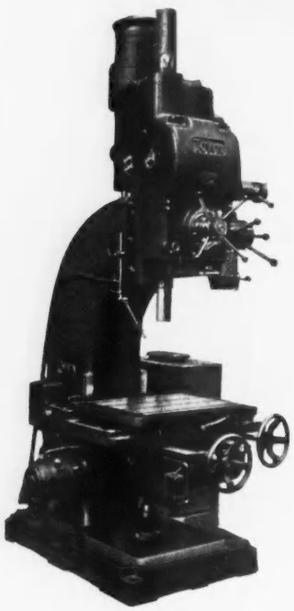
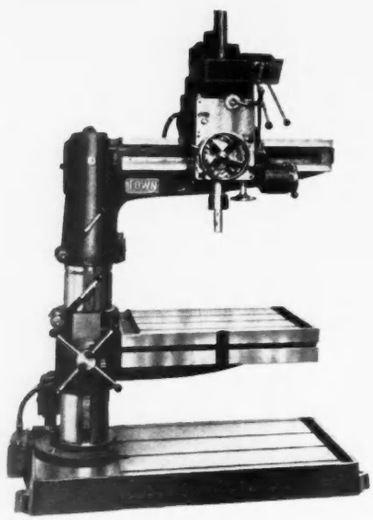


MODEL AE2: VERTICAL DRILLING MACHINE (heavy-duty model). Two sizes: 36 in. and 42 in.; 18 speeds; 8-420 r.p.m. or 15-790 r.p.m.; drills 3½ in. from solid in mild steel.



MODEL AE5: RADIAL DRILLING, TAPPING and STUDDING MACHINE. 42 in.; 9 speeds; 88-1,450 or 60-1,000 r.p.m.; drills 1½ in. from solid in mild steel or 1½ in. in cast iron.

MODELS EG4 and EG8: RADIAL DRILLING MACHINES (for girders, plates, structural parts, etc.). Each model in five sizes: 4 ft., 5 ft., 6 ft., 7 ft., 8 ft.; 4 speeds; 160-600 r.p.m. (EG4), 8 speeds; 20-500 r.p.m. (EG8); drills up to 2 in. from solid in mild steel. Also made with single speed.

OTHER MACHINES IN THE RANGE

are detailed in a folder 'GO TO TOWN' which is available on request. Variations on the standard range can be undertaken, and examples are also illustrated in the folder.

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The Tilley Lamp Company manufacture a unique range of portable paraffin pressure Floodlights, Storm Lanterns, Lamps and Heaters for use in engineering and industry.

Illustrated can be seen the powerful, portable 5,000 c.p. Tilley Floodlight, the F.L.6, which gives 48 hours of independent light on only 6 pints of paraffin.

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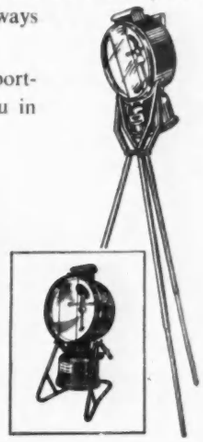

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We now have an equally efficient range of Lamps and Heaters operating on PROPANE/BUTANE.
Details of these will interest you.

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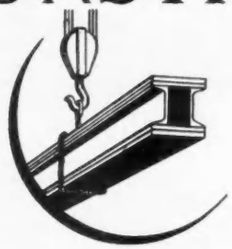

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"Purrrr!"

"Since they fitted L & C Piston Rings, I mean"

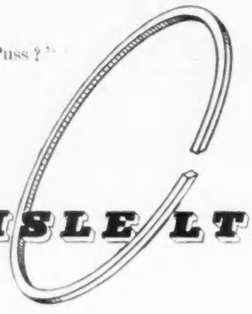
"Purrrr!"

"Engines runnin' as sweet and smooth as a bowl o' cream, ain't they?"

"Purrrr!"

"How would you sum up these L & C rings, Puss?"

"Purr-fect!"



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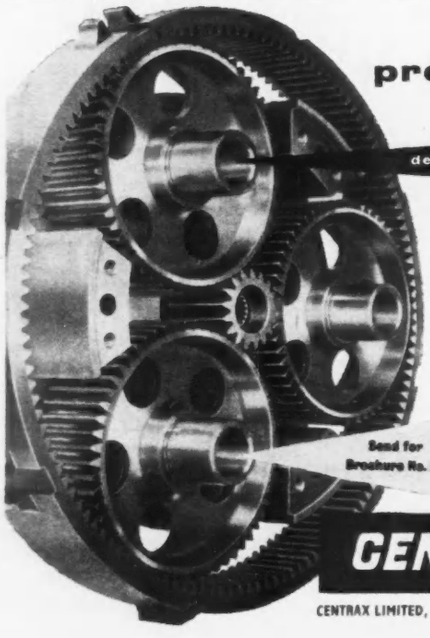

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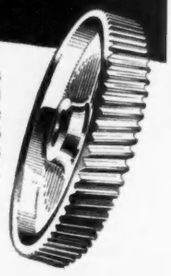
design and manufacture of complete gear boxes

helical and spur gears up to 12" diameter in prototype or production quantities

a range of precision ground case-hardened gears



Where it is possible to use pre-designed gears quick delivery can be made from the range of 6 diametral pitches with 3 helix angles or in straight spur.

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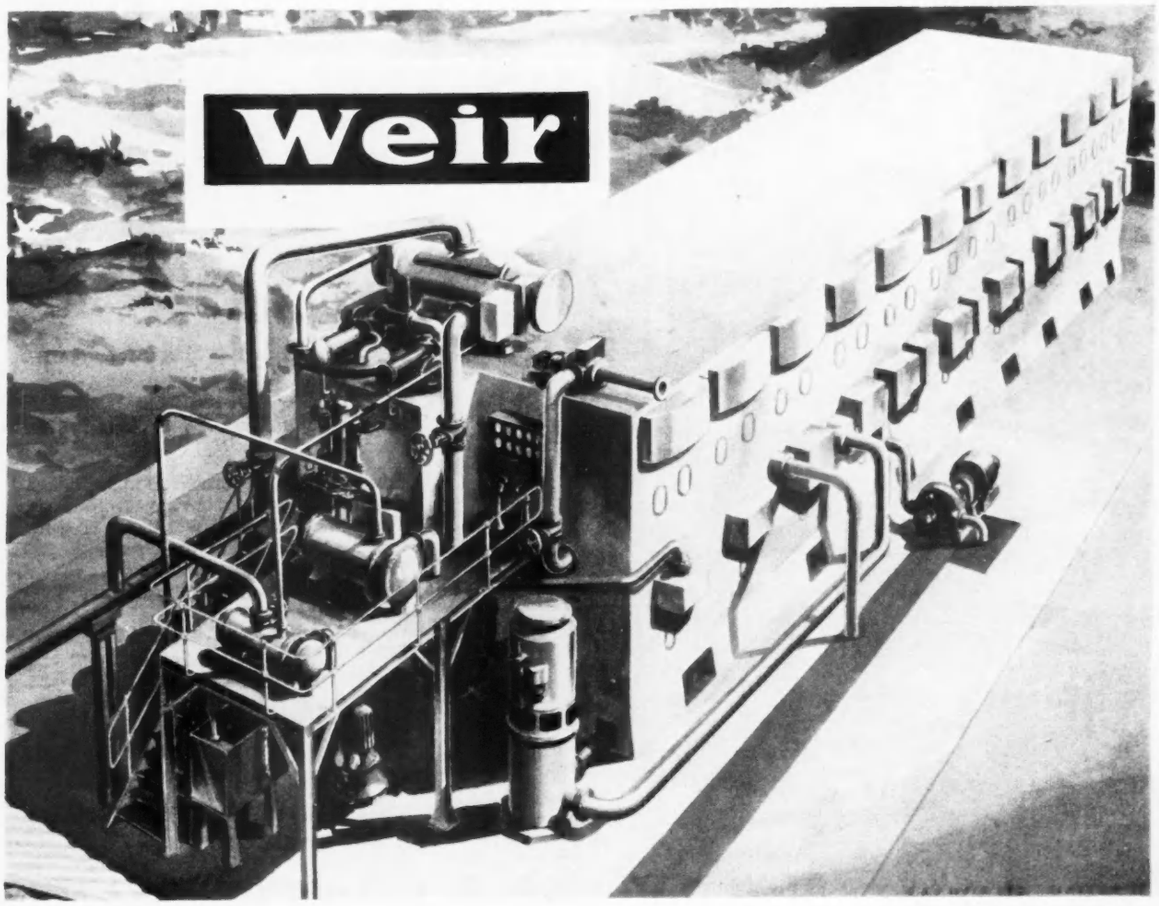

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The World's first installation in a Temperate Zone

There is an obvious need for large-scale sea water distillation in rainless areas where industrial development is vital to the economy.

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This plant is a half-a-million-gallon-a-day insurance policy against the risk of drought, which could ruin the flower and tomato crops which are the mainstay of the island's economy.

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* To be completed early in 1960.

Fresh Water from the sea is produced by Weir plant at

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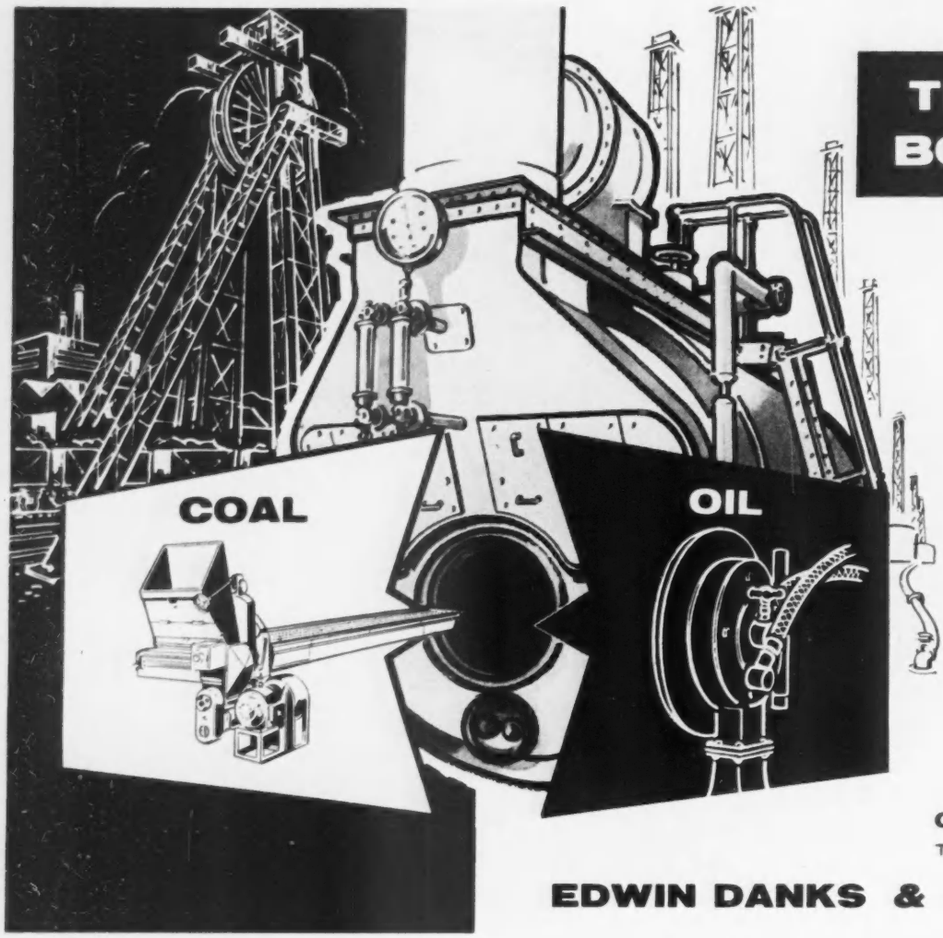

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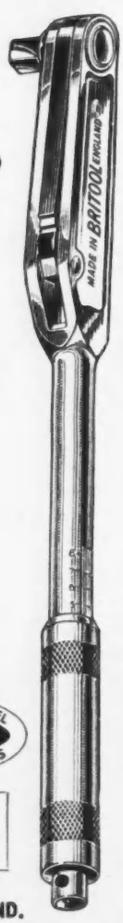

SAFEST & GREATEST TORQUE WRENCH OF THEM ALL.
Fast, Accurate, Foolproof. Will tighten 1, 100 or 100,000 nuts to exactly the same degree of tightness.

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Manufactured at BRITOOL WORKS, BUSHBURY, WOLVERHAMPTON, ENGLAND.

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Here is the perfect jointing for high pressure smooth surface or screw unions!

Tested and recommended by the Ministry of Supply (MTV Branch) Reference No. VG.6/300/FIR for export to tropical countries.

OSOTITE—the modern scientific sealing which has been proved by rigorous tests to be the perfect jointing for smooth surface and screw unions. OSOTITE is a simply applied liquid compound, impervious to heat, petrol, oil, grease, water and steam which ensure in a few minutes a HIGH PRESSURE GAS, AIR or WATER-TIGHT JOINT. Write for full details and prices.

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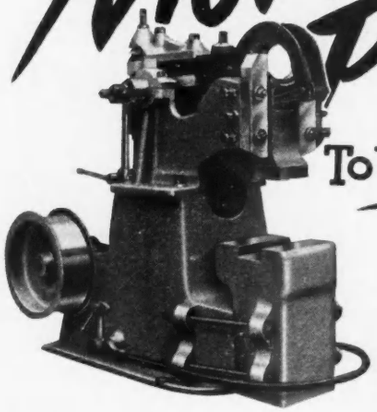

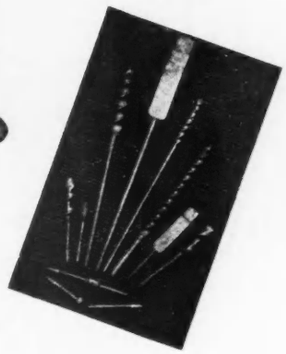

275/300 blows per minute.
Average size of work 1¼" bar.
Adjustable stroke and guides.
Rubber cushioned overhead motion.
Loose Anvil Block.
Separate motor stand available.

A typical example of the type of work accomplished on this machine (illustrated right).

For High Speed Precision Forging—the Model '100' POWER HAMMER.

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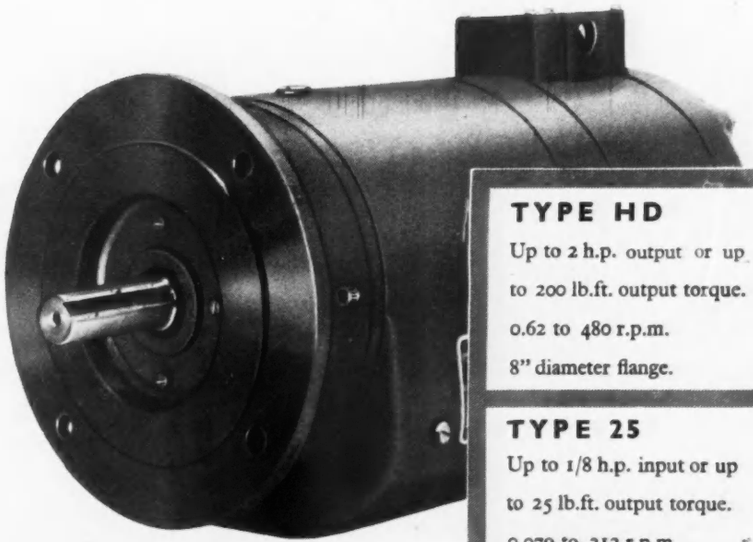
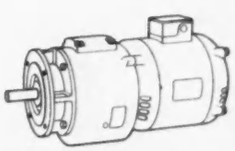
flange mounting geared motors

All NECO co-axial geared motors can be supplied with flange mounting instead of feet to enable the unit to be bolted accurately to your machine.

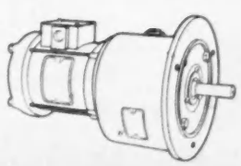


TYPE DS
Up to 1/2 h.p. input or up to 100 lb.ft. output torque. 0.5 to 475 r.p.m. 8" diameter flange. Removable feet can be supplied with this unit.

TYPE HD
Up to 2 h.p. output or up to 200 lb.ft. output torque.
0.62 to 480 r.p.m.
8" diameter flange.



TYPE 25
Up to 1/8 h.p. input or up to 25 lb.ft. output torque.
0.079 to 312 r.p.m.
8" diameter flange.



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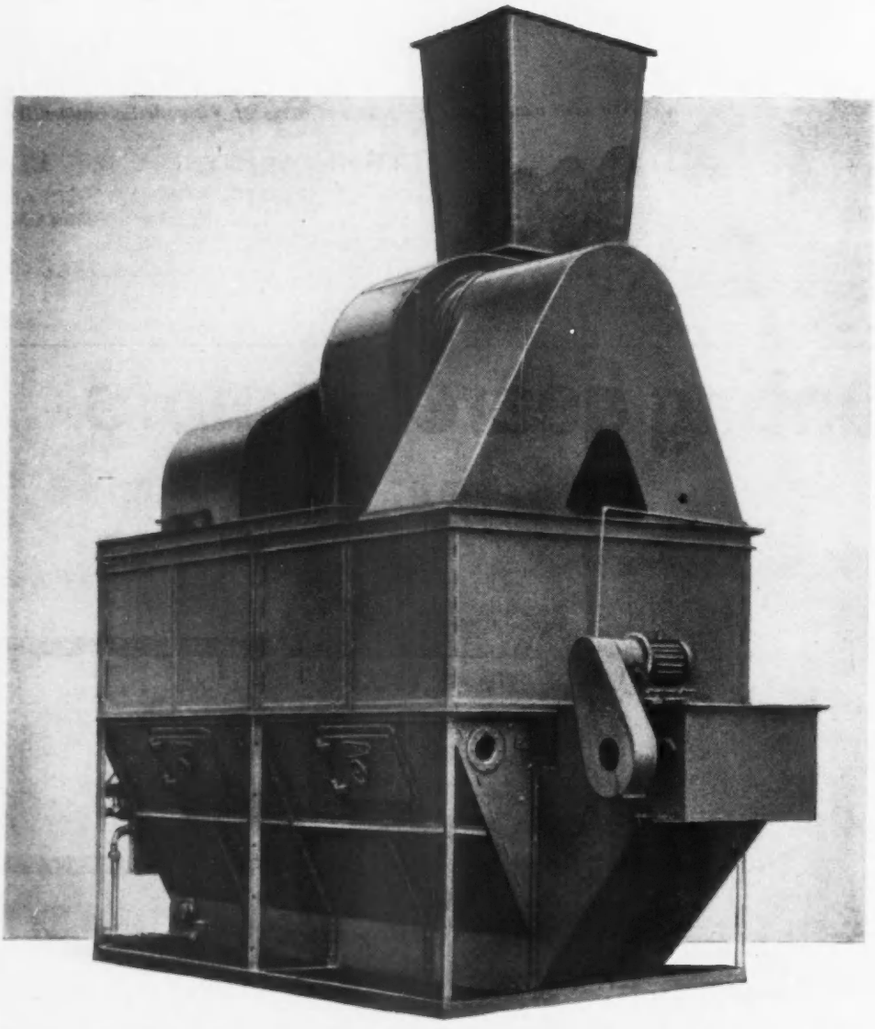

Midac Dust & Fume Control Plant can provide the answer to all industrial dust collection problems.

One of the Midac range of Self Induced Spray Wet Dust Arresters. Manufactured with Capacities from 250 c.f.m. to sixty c.f.m.

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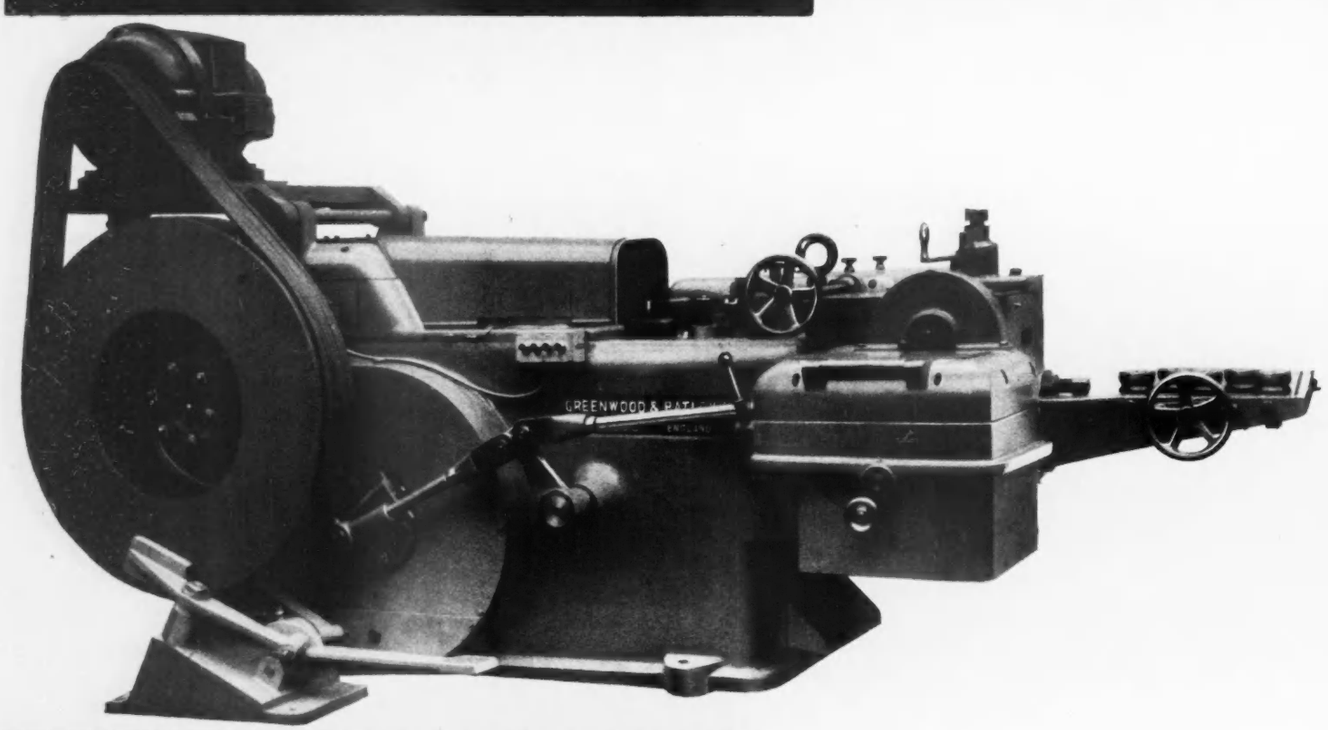
Also available is the standard range of Cold Forging Machines, handling sizes from $\frac{1}{8}$" to $\frac{1}{2}$".

high speed cold forging

GREENBAT *machines*



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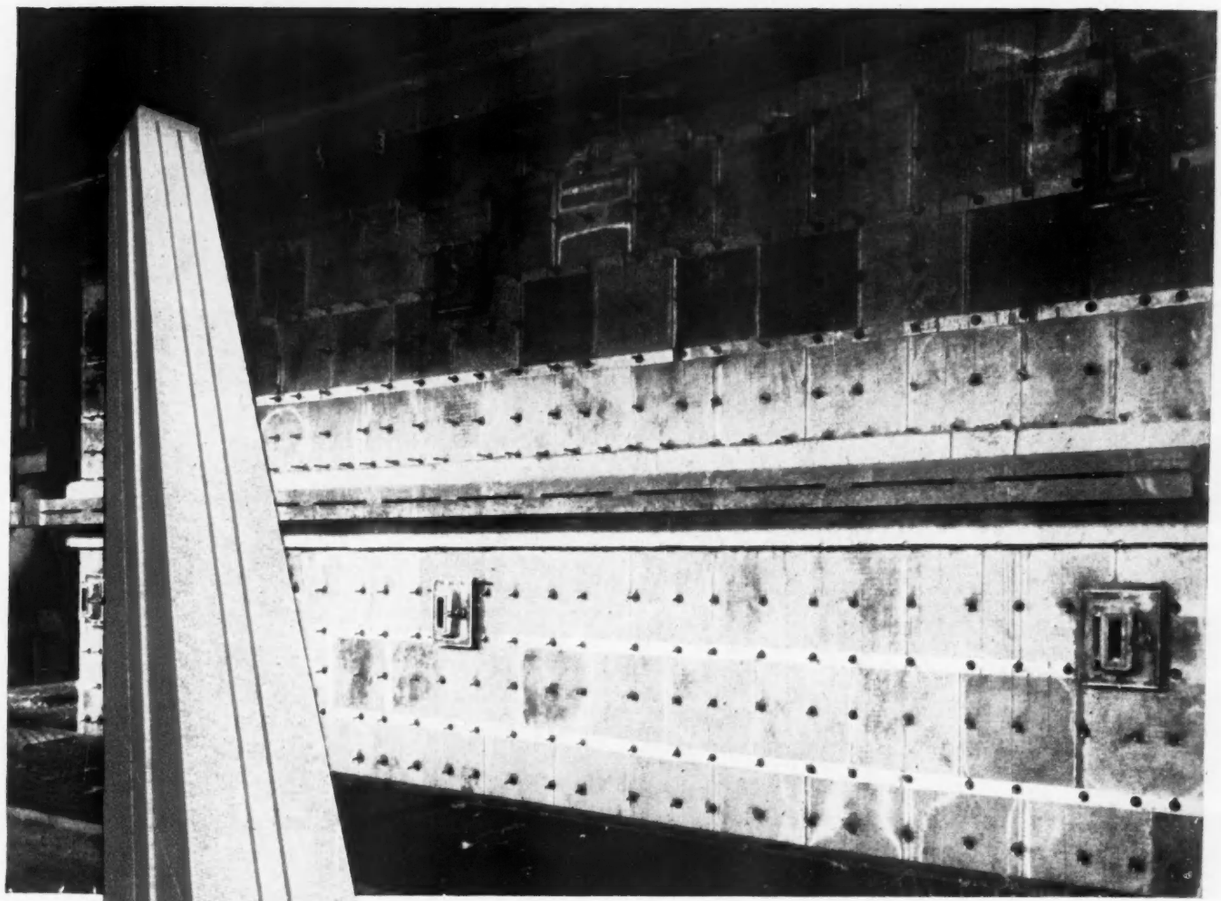

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The illustration shows the refractory cladding applied to a very large power station boiler. In this instance prefabrication was extensively used, and the photograph shows the installation ready to receive the low temperature insulation. This particular system, developed and patented by the R.B.H. GROUP, is now used very widely on modern power station boilers.

R. B. HILTON'S activities range from the refractory and insulation work involved in the largest national and industrial undertakings down to the repair of the smallest self-contained boiler.

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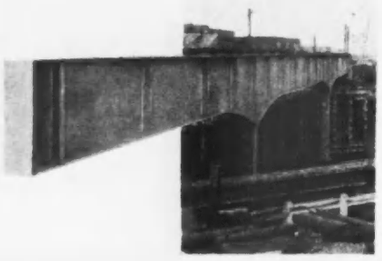
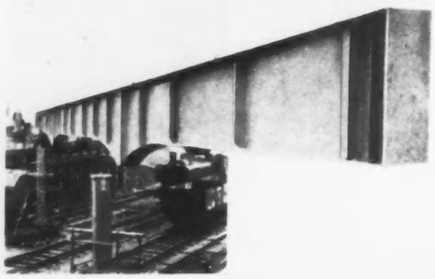
Another speedy bridge replacement – by BUTTERLEY





The reconstruction of Bridge No. 5 carrying the L.M.R. suburban tracks over the Western Region main lines between Willesden and Acton Central was carried out by Butterley for the Chief Civil Engineer, British Railways, London Midland Region. Rolling out of the old bridge, erection of new columns and the rolling in of the new bridge were carried out during a week-end closure of the L.M.R. lines and a short closure of the W.R. lines below.

Sub-contractors : Leonard Fairclough, Ltd.

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B.51

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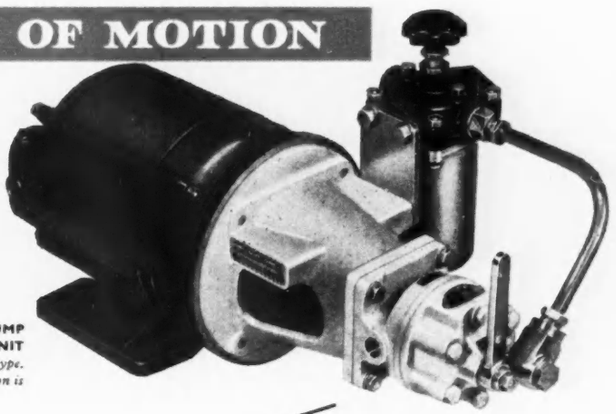
CONTROL OF MOTION



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Adjustable volume type. A fixed volume version is also supplied.

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Savery Hydraulic pumps are consistently smooth and precise in operation at pressures up to 1,500 p.s.i. and running speeds as low as 20 r.p.m. The Savery Annular Piston oil pump is capable of infinite variation between zero and maximum volume.

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It is the most up-to-date advance on the highly successful Hydraulic Resistance type which has been in the lead of quality Sawing Machines for many years.

Superior to previous Hack Sawing Machines it is capable of obtaining a greater performance from thinner high-speed steel blades and excels particularly where special alloys and high-tensile steels are used.

The triple-acting hydraulic control unit uses more of the blade and as the teeth are more evenly loaded, gives longer life and greater output per blade.

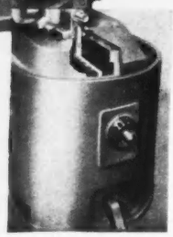
newest—most advanced metal sawing machine available to-day

Send for details of the new

WICKSTEED
REGISTERED TRADE MARK

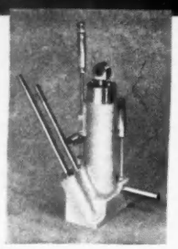
'Hydramatic'

No. 8 — 8" × 8" CAPACITY



All Control Settings and Motor Starter accessible from one position only.

Adjustable motor trip switch allows machine to stop in any position at finish of cutting cycle.



Triple - Acting hydraulic unit enables blade pressure to vary according to section being cut.

Self - priming geared suds pump, totally enclosed, but easily accessible.

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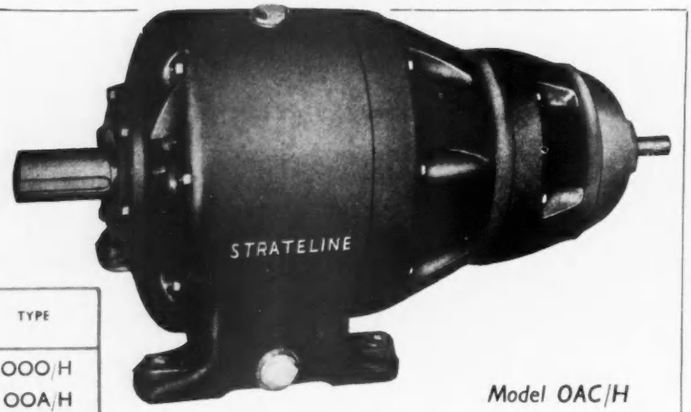
Any Ratio

FROM 10,000: 1 TO 1,000,000: 1

ALL DIMENSIONS IN INCHES

MAX. TORQUE LBS. INS.	SHAFT CENTRE HEIGHTS	OVERALL HEIGHT	OVERALL WIDTH	OVERALL LENGTH	TYPE
300	3	6¼	5¾	12 1/16	OOO/H
750	3⅝	7 7/16	6⅞	14 11/16	OOA/H
1500	4½	8 11/16	8⅛	16 7/16	OOB/H
[illegible]	5	10¼	9½	20	OAC/H
6000	6⅛	14⅛	11¾	22⅝	OAD/H
12000	7½	17	14	25 13/16	OBE/H
24000	8½	20⅞	17	32⅝	ACF/H
48000	10¾	25½	21	39¼	ADG/H



Model OAC/H

TRIPLE STAGE STRATELINE FIXED REDUCTION SPEED REDUCERS TORQUES FROM 300 LBS. INS. TO 48,000 LBS. INS.

The "Hypocycloidal" gearing used makes possible ratios of up to 100 : 1 in each stage. The triple stage unit can be supplied in any ratio between 10,000 : 1 to 1,000,000 : 1 provided the final ratio is the product of three whole numbers in the single stages. For example 53 : 1 × 44 : 1 × 76 : 1 would give an overall ratio of 177,232 : 1. These reducers can be supplied as separate foot mounted units suitable for direct coupling, belt on chain drive, or complete with flange mounted motors. Study these overall dimensions against the available ratios and compare with all other forms of speed reduction.

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Type FA.27.....25/30 kW continuous output available from Stock.

Type FA.29.....50/60 kW continuous output available Autumn 1959.

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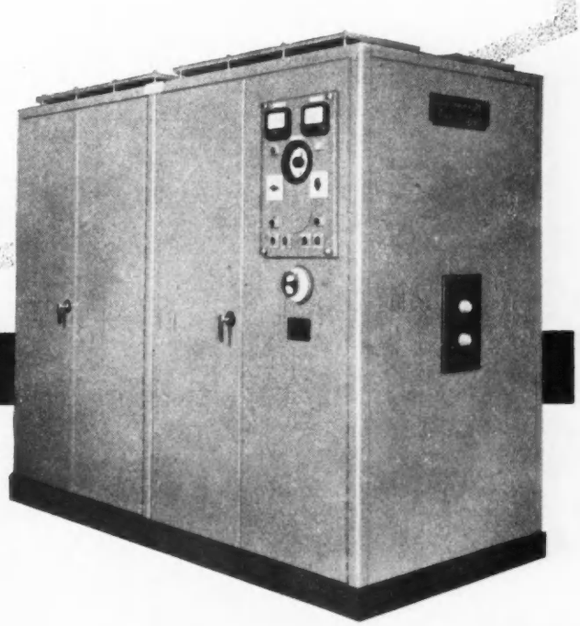

Publications 5857-2 and 5857-3 will be gladly sent on request, also our booklet G 13026 "Electronics in Industry".

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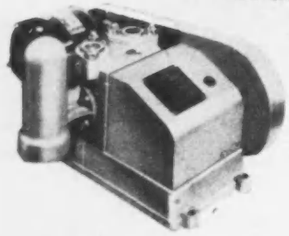

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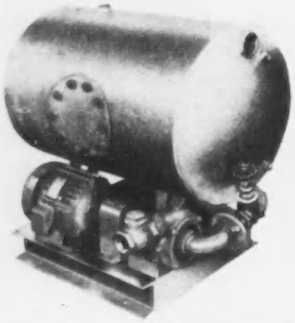

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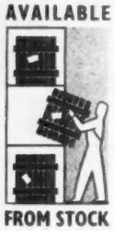

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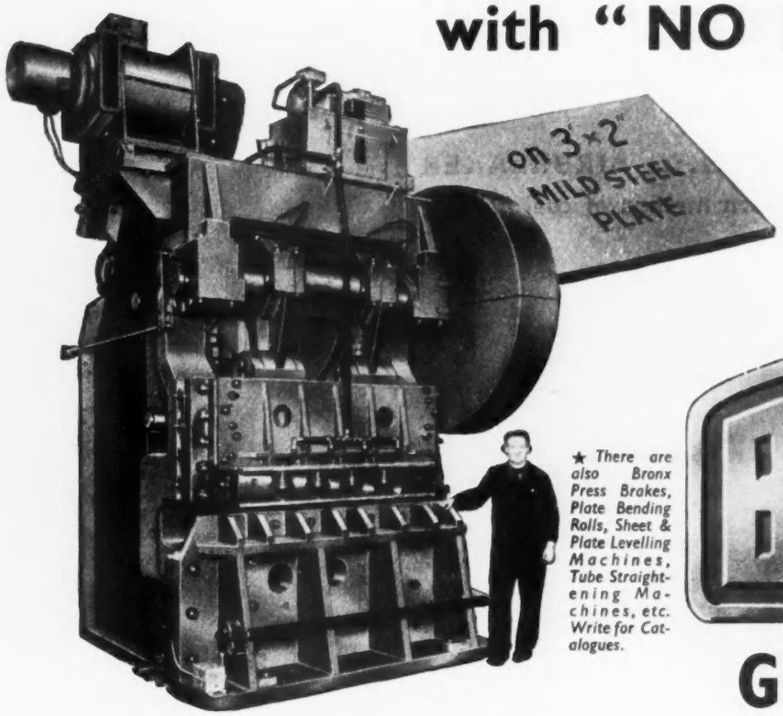

Illustration shows Bronx Heavy Duty Plate Shears, capacity 3' × 2" as supplied to Messrs. Appleby Frodingham Steel Company, Scunthorpe.

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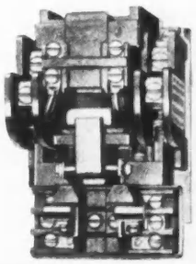
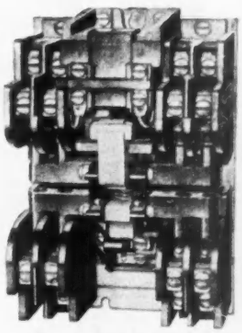
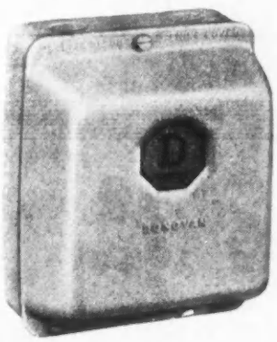


● 2-pole Open Style Relay with two change-over coil circuit contacts.



● 8-pole Open Style Relay with one change-over coil circuit contact.



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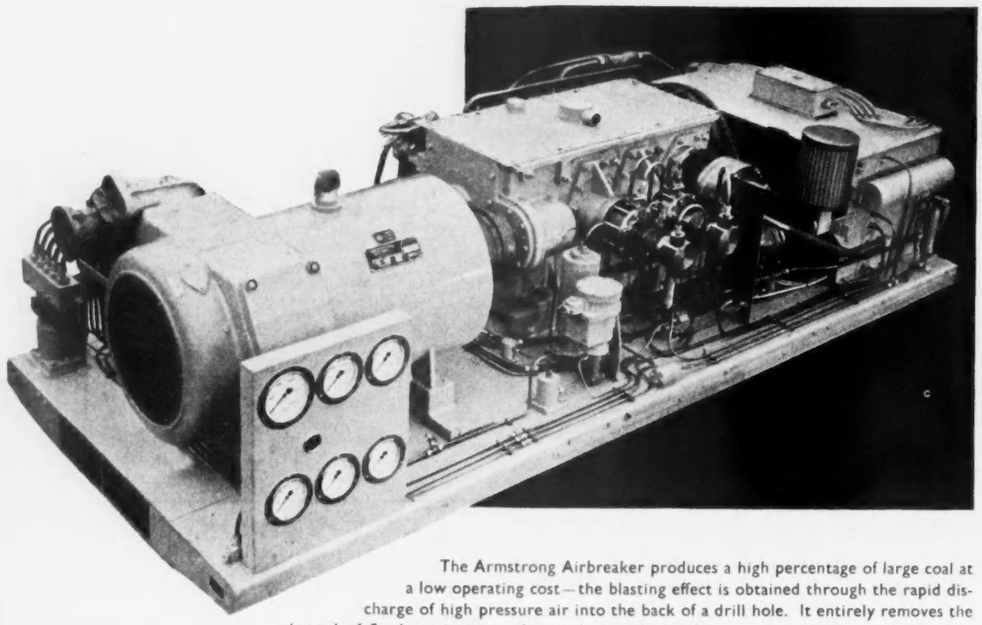

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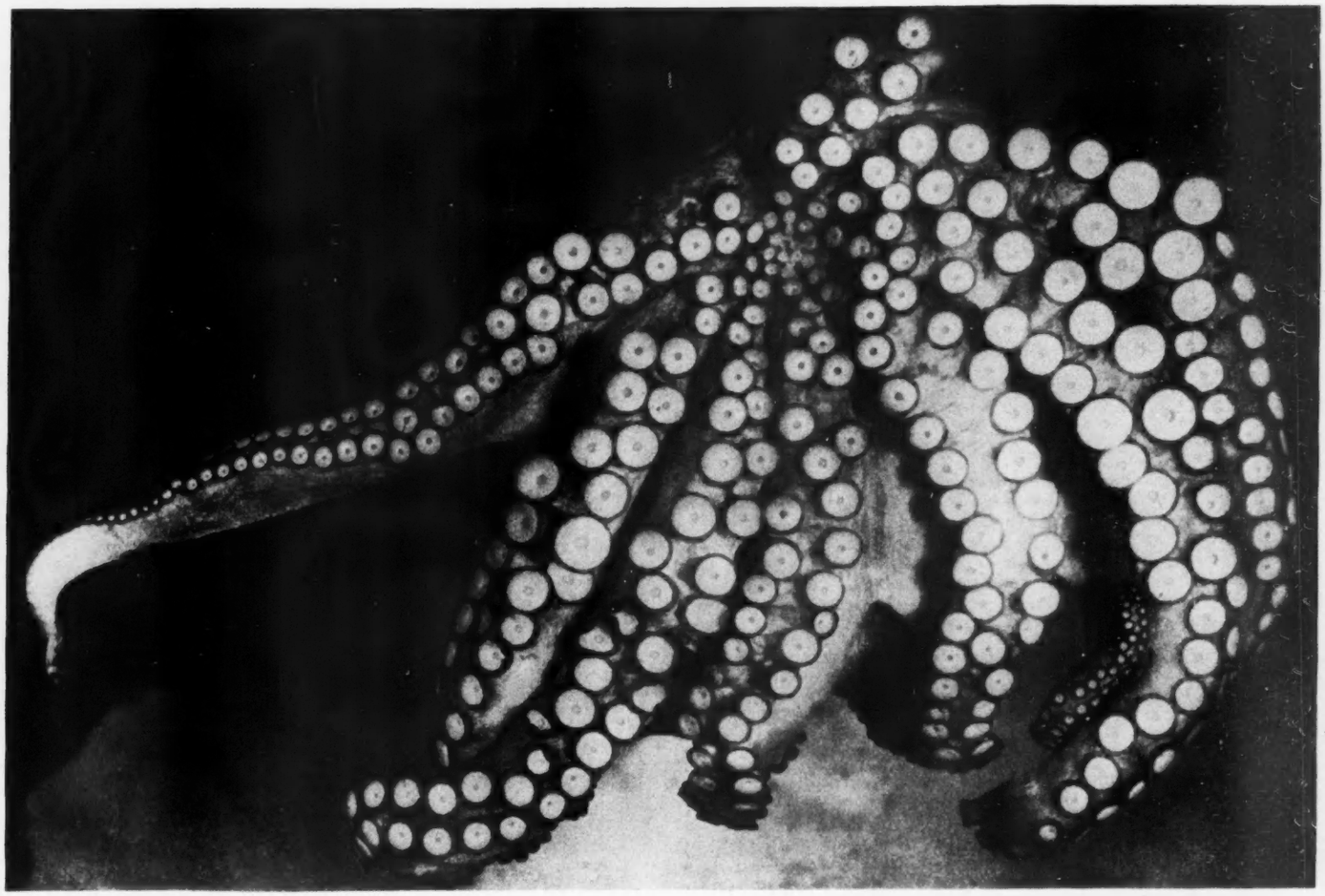

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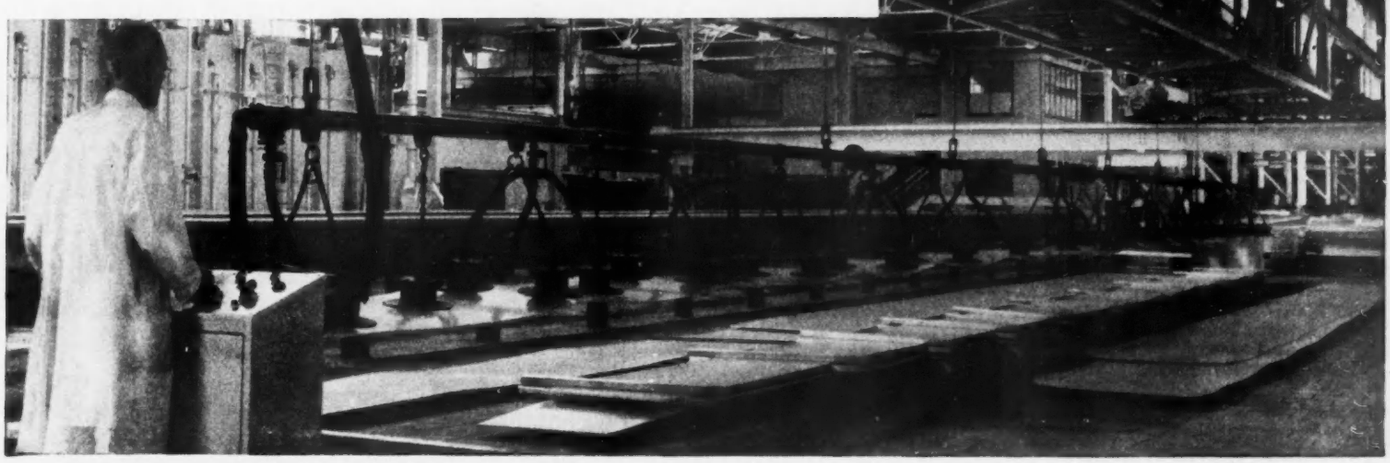

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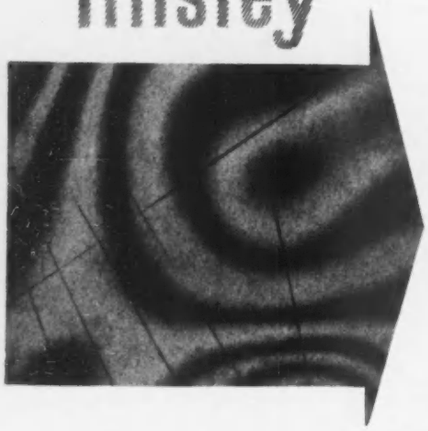

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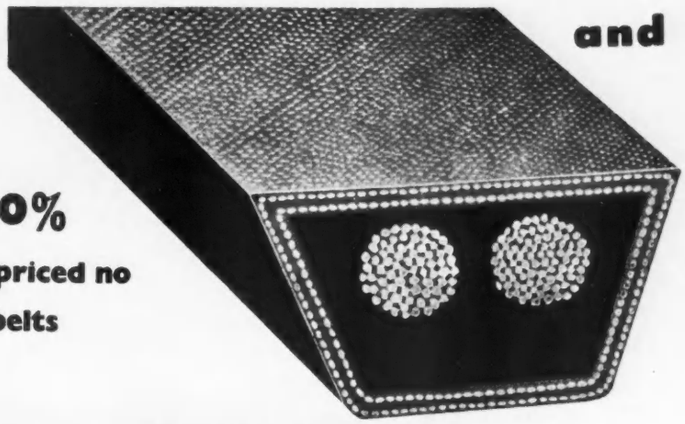
between this  and any other V-belt

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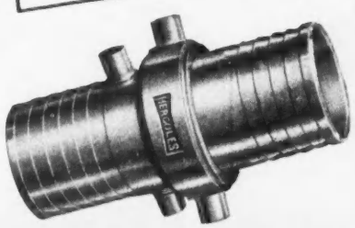

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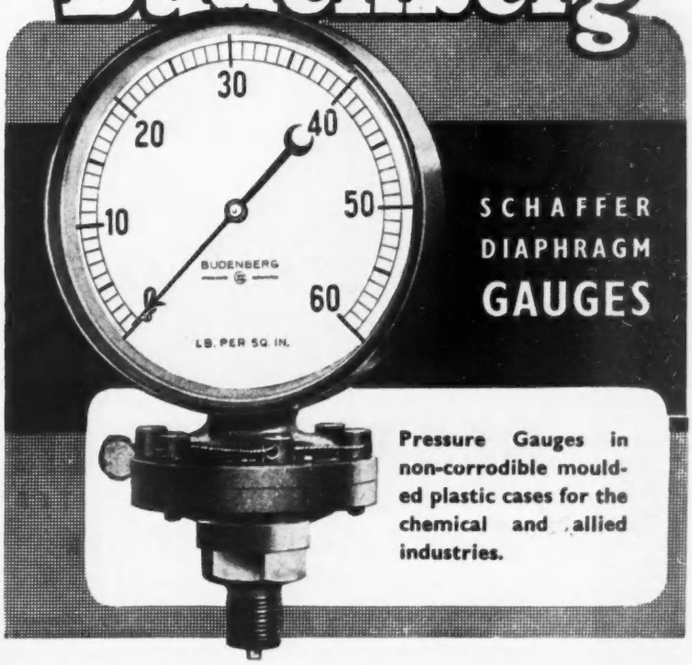

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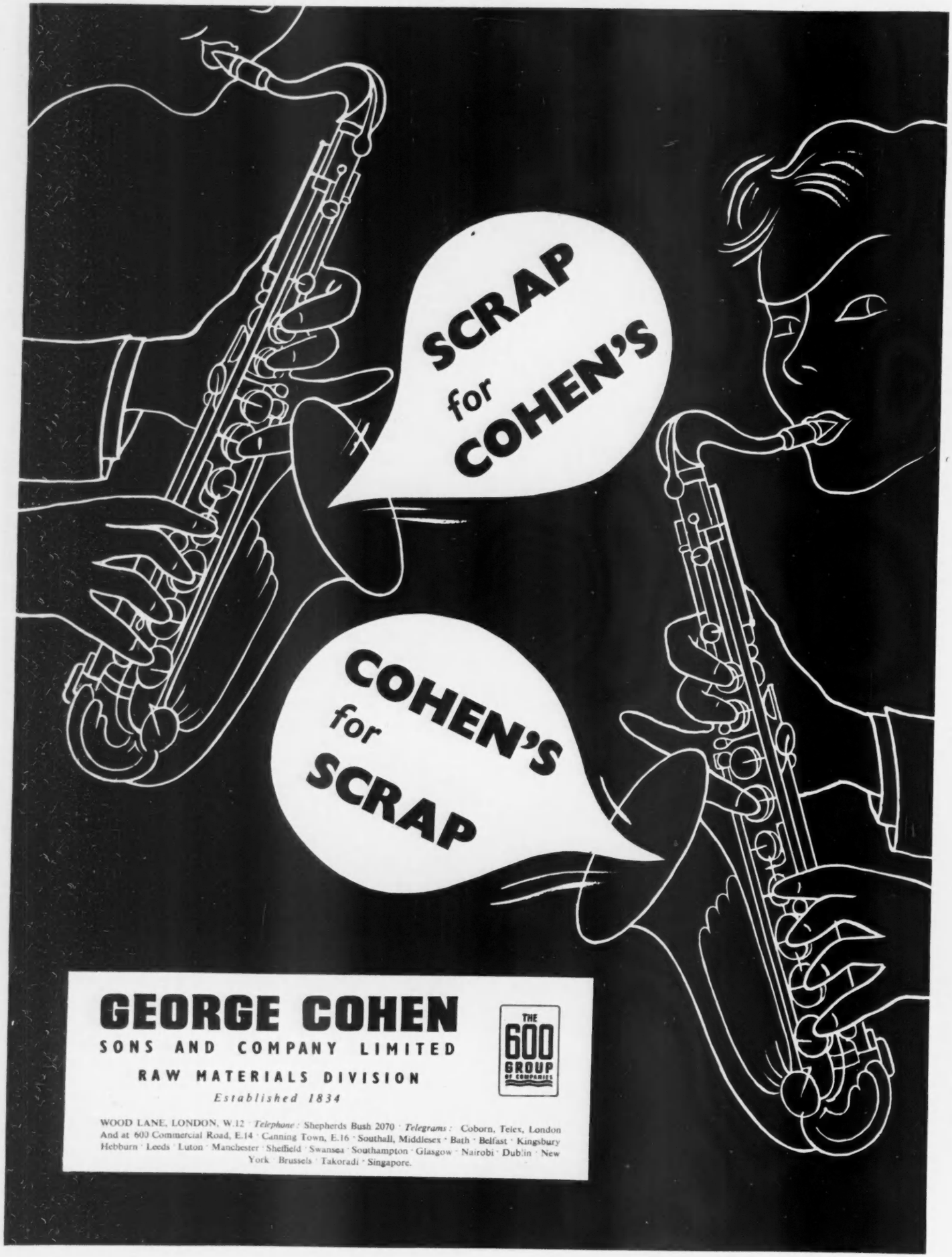

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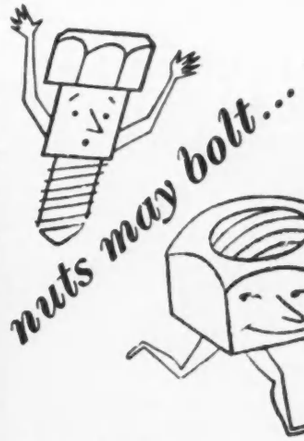

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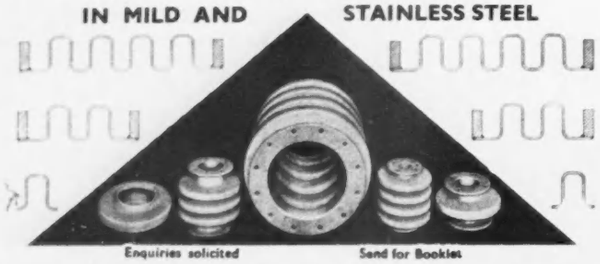

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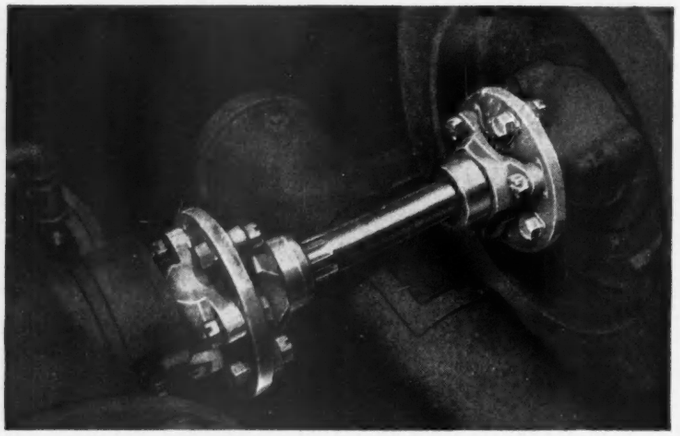

★ Are easily assembled.
★ Give extreme torsional flexibility.
★ Absorb irregularities in load variations.
★ Axial and parallel misalignments are corrected.

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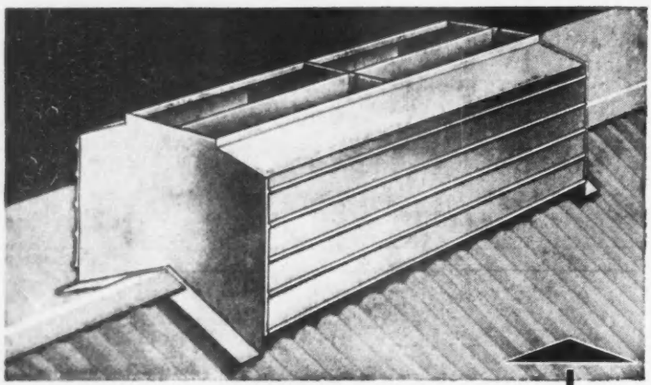
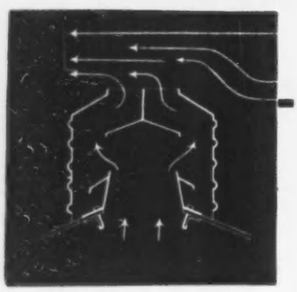
Complete Ventilation—and no mechanical aid



THE NEWRIDGE VENTILATOR

No matter what the weather conditions, the Newridge always gives maximum air extraction without any mechanical aid.
Specially designed air baffles create air jumps to aid stack-action and natural outflow of air—which means that your Newridge gives complete ventilation with no running costs. And during cold weather controlled exhaust can be provided, if required.
The Newridge ventilator, constructed from Aluminium Alloy (B.S. N.S.3.), is light in weight and corrosion resistant.

EASILY FITTED TO ANY TYPE OF ROOF



Maximum Air Extraction
The diagram of a cross-section of the ventilator shows how "stack-action," assisted by the wind, forces foul air from the building.

Free Technical Advice
We shall be pleased to place our many years of technical and practical experience at your disposal without any obligation on your part.

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by the makers of Kinylon and Kinrod Grilles

solve the problem

of wide entrances and a sloping road. The bottom rails on these Kinnear Shutters are shaped to accommodate the rise of the road, to ensure good closure and complete weather protection.

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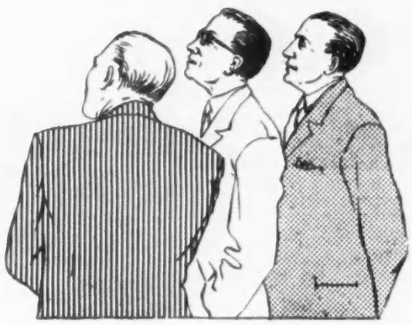
The illustrations show just a few examples of Cull craftsmanship.

All are completely hand forged. We supply hand and smithed forgings to any steel specification in the "as forged," normalised, annealed or oil hardened and tempered condition.



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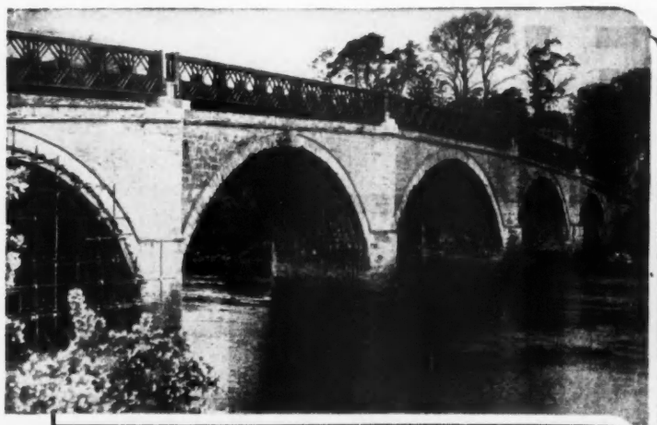
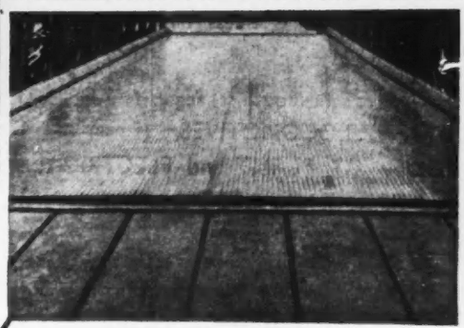


COURTESY: SCOTTISH HOME DEPARTMENT (ROADS DIVISION)

Bailey Bridges the Gap...



...on a Trunk Road in Scotland

With the increase in weight of modern traffic, many of the older type of bridges may require to be strengthened, particularly in order to carry abnormal indivisible loads. In this particular project a Bailey Bridge is erected on the existing stone piers and decked with Storey Steel Decking which is asphalt carpeted.

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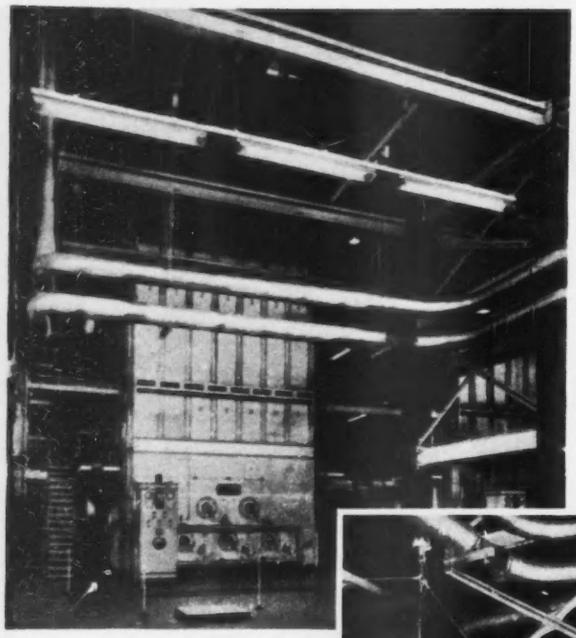
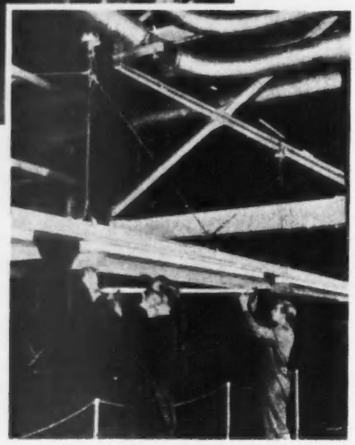


Fluorescent Trunking in the boiler house at Vauxhall Motors, Luton.



Here the lights have been lowered by means of L.E.F. gear for servicing at a convenient height.

TIB 125

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L.E.F. Raising and Lowering Gear

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BOGIE SIDE FRAMES

. . . part of the Bogie Assembly produced for the Gloucester Railway Carriage & Wagon Company Ltd., and widely used Overseas on the Nigerian, Ghana, Ceylon, Sudan and Argentine Railways.

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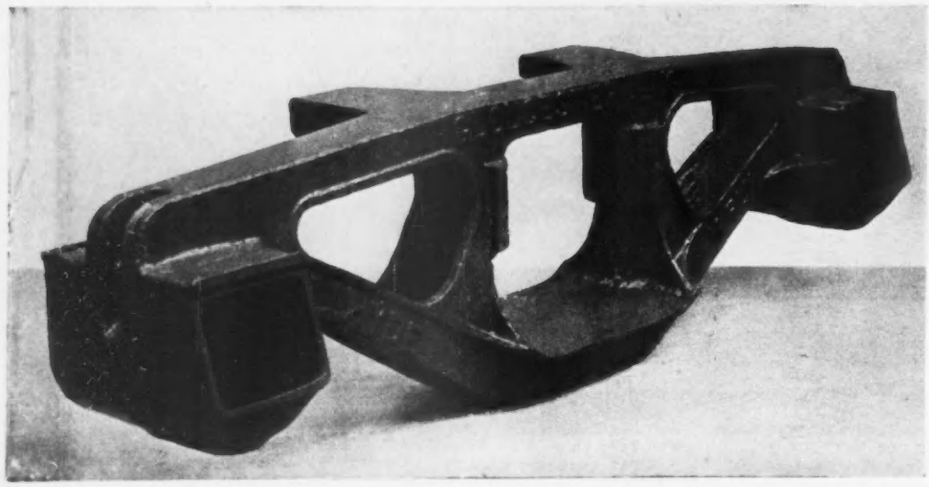

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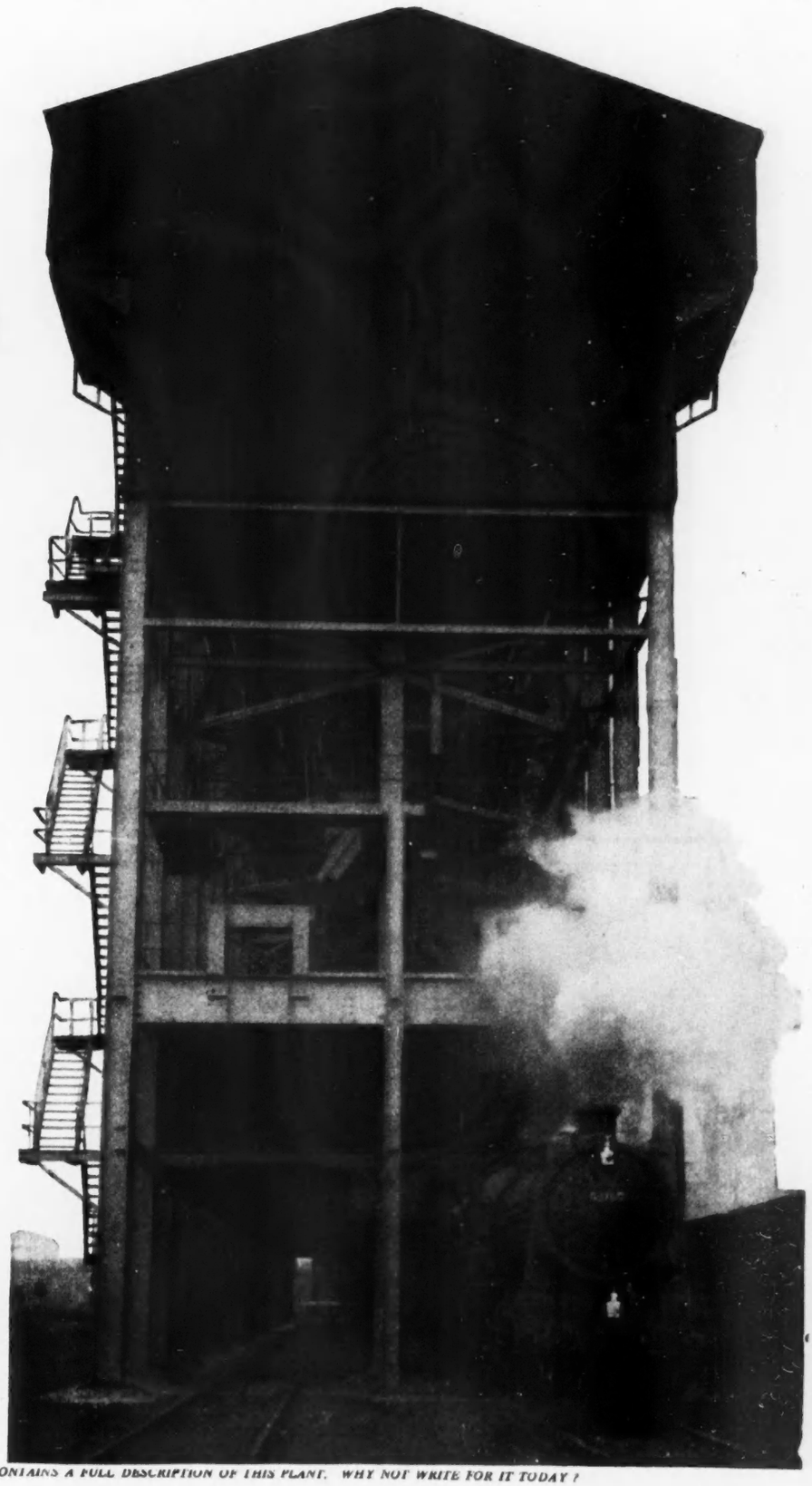

Another train carrying 500 tons of ore leaves Tyne Dock, South Shields, for the blast furnaces. The ore has been handled in a Simon plant that moves it at a maximum rate of 1500 tons an hour from ship to shore. From Simon storage bunkers with a maximum capacity of 12,700 tons, the ore is weighed out into two lines of loading out hoppers. A train draws under one of the lines and over 500 tons of ore are released in a few seconds to waiting wagons. Every operation is carefully synchronised and controlled. In the three years after its commissioning, this plant handled over three and a half million tons of ore. Plants designed and built by Simon are handling a wide variety of materials all over the world.

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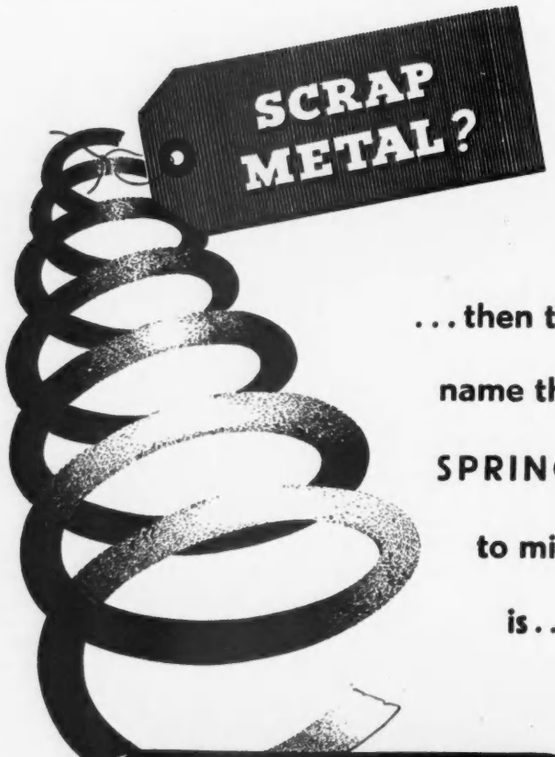

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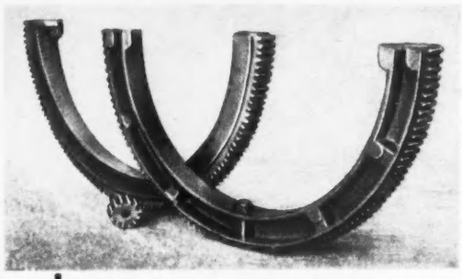

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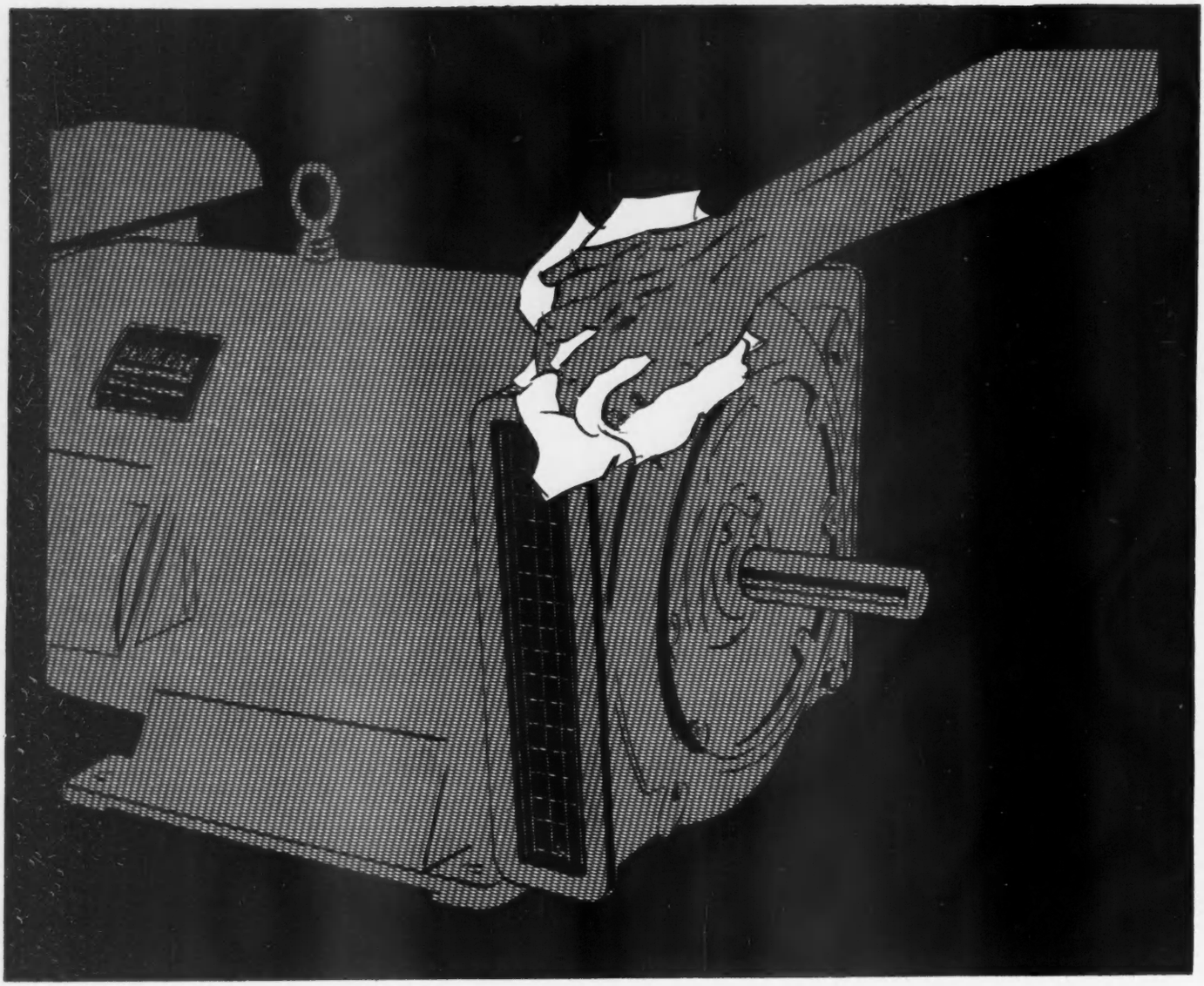

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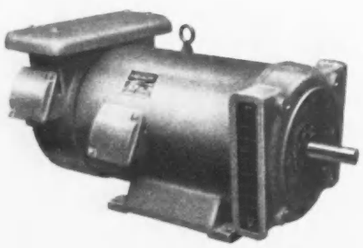

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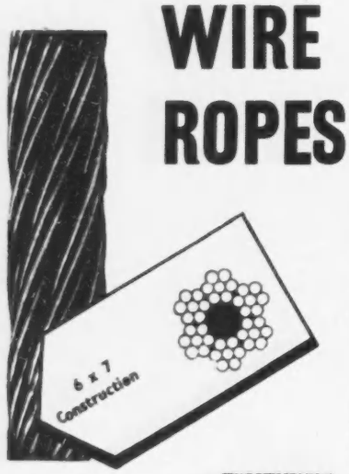

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If your job calls for wire ropes at all, then there's a place for Sheffield Wire ropes—for dependability, strength and a long working life.

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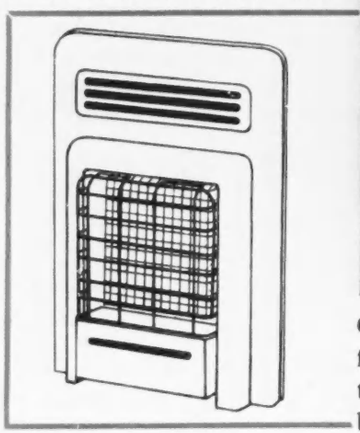

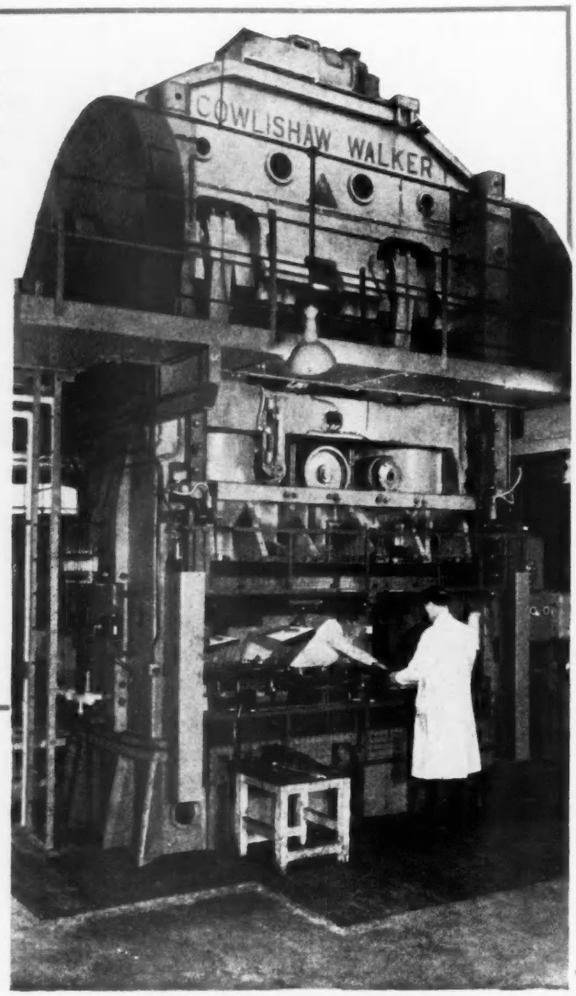

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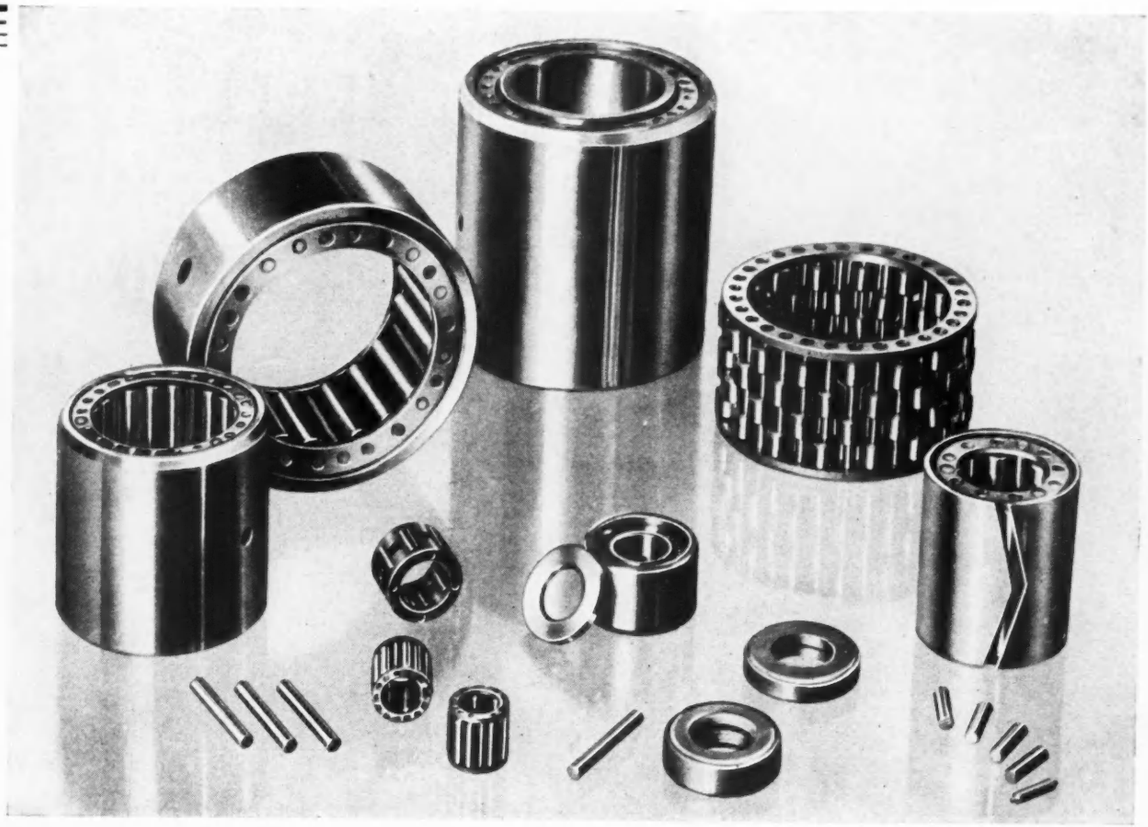

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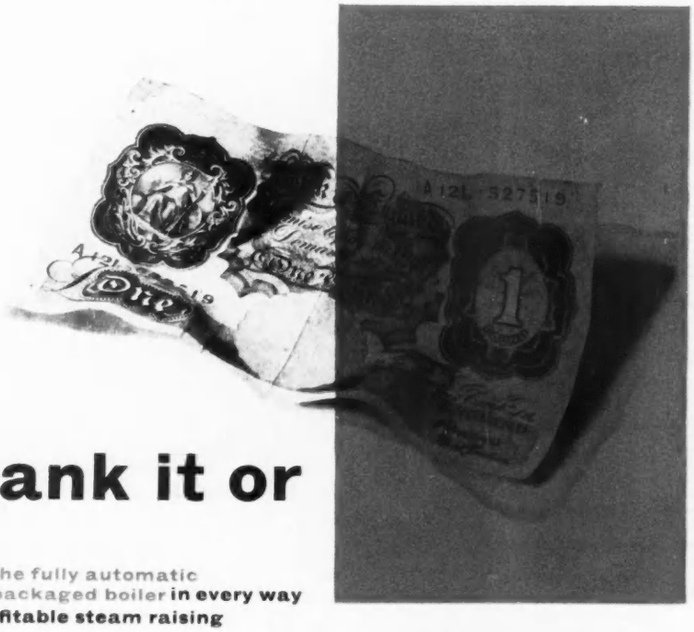

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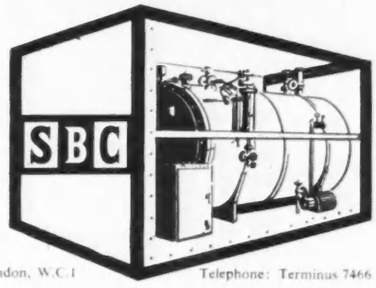

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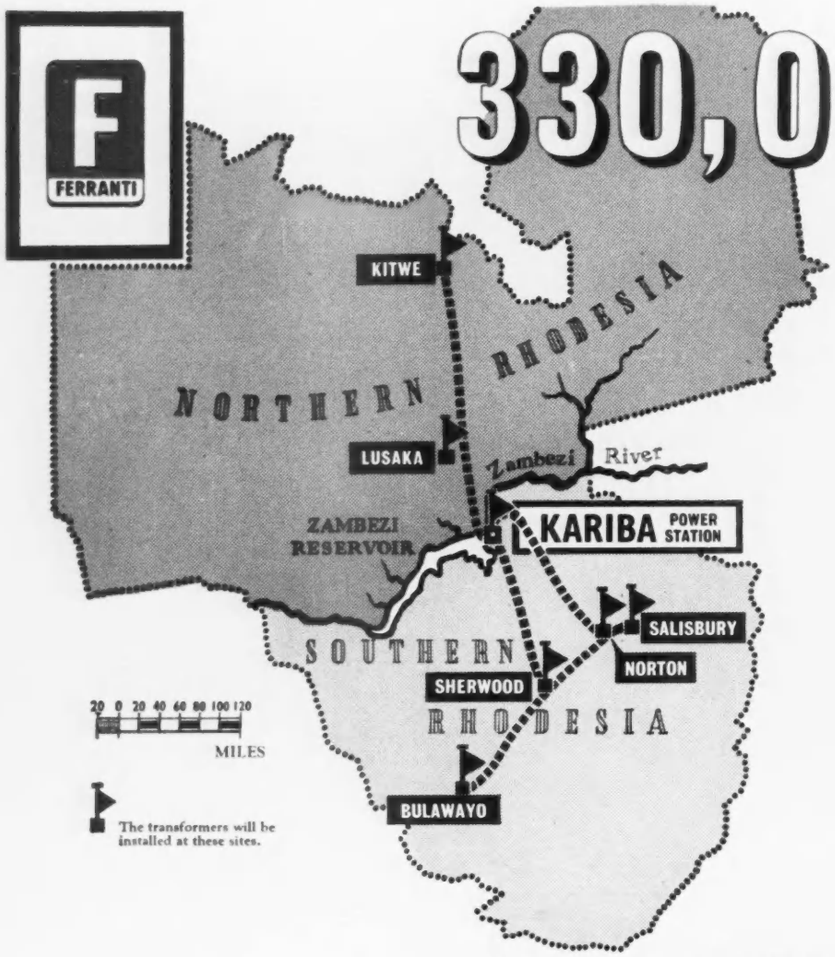
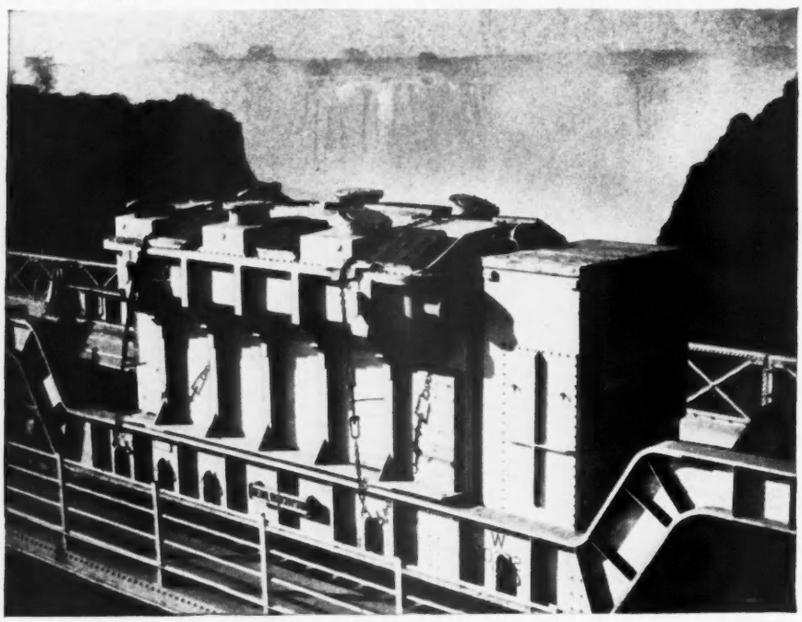
330,000 volts transformers for Kariba



The contract awarded to Ferranti Ltd. by the Federal Power Board, Rhodesia and Nyasaland, comprises two 120,000 kVA, 330/234 kV 3-phase auto transformers with series boosters, nine 60,000 kVA, 330/88 kV — one in commission at Norton — and two 60,000 kVA, 330/33 kV — one in commission at Salisbury — 3-phase double wound transformers.

The consulting electrical and mechanical engineers are Messrs. Merz & McLellan.



A Ferranti large power transformer crossing Victoria Falls bridge on its way to the Kitwe sub-station for the Kariba Hydro-Electric scheme. Two of these transformers on special well-wagons form part of the load on a goods train. Each transformer weighs 67 tons.

Specify* FERRANTI TRANSFORMERS *famous throughout the world

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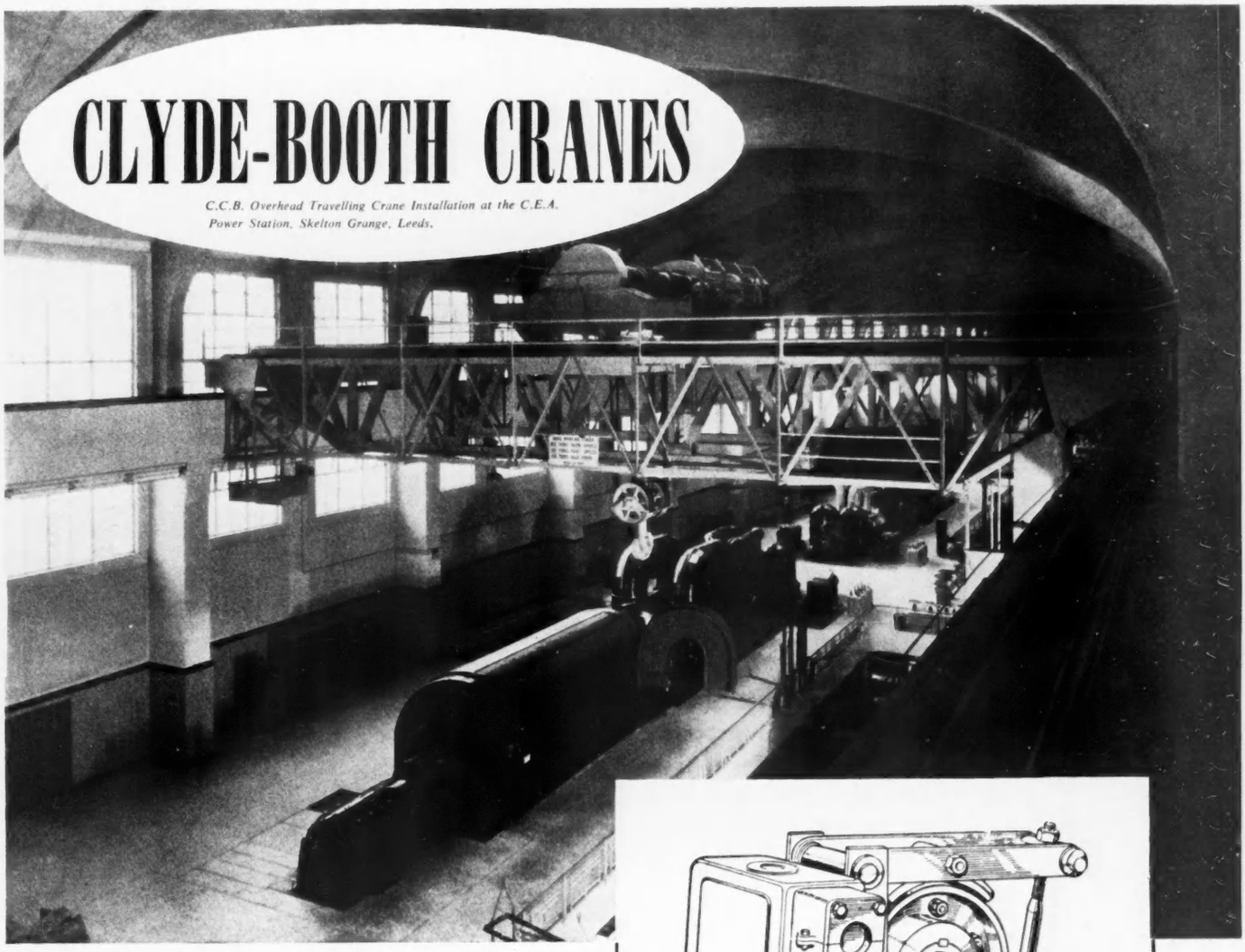

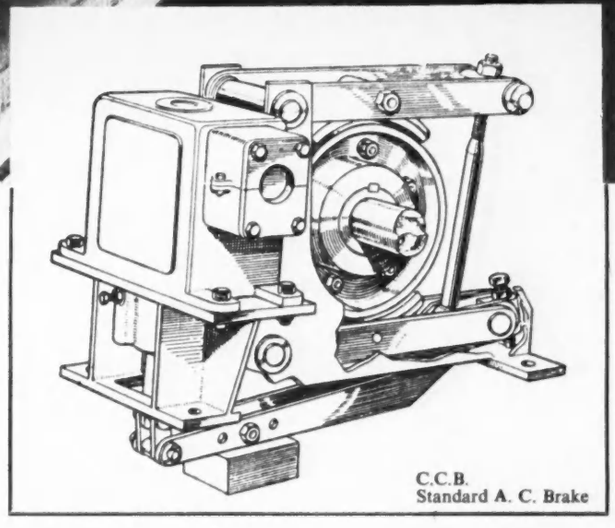

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The C.C.B. Solenoid brake is a compact all steel design, built to give long working life with a minimum amount of adjustment. Detail refinements include:

- **Hardened and ground pins working in phosphor bronze bushed links.**
- **Die pressed friction linings ground to form after fitting.**
- **Quick and easy adjustment to compensate for lining wear.**
- **Wide brake drum and shoes provide large friction area.**

CLYDE BOOTH

CLYDE CRANE & BOOTH LTD. *Incorporating:*

Joseph Booth & Bros.,
Union Crane Works, RODLEY, Leeds.
Tel.: Pudsey 3168 (6 lines). Grams: "Cranes," Rodley, Telex. Telex 55159.

Clyde Crane & Engineering Co.,
MOSSEND, Lanarkshire.
Tel.: Holytown 412 (6 lines). Grams: "Clyde," Motherwell, Telex. Telex 77443.

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THESE THINGS DON'T HAPPEN

IF YOU KNOW THE ROPES

These photographs show some typical instances of damage to ropes and associated equipment caused by mishandling, wrong fitting or neglect. In each case serious damage was caused to the Wire Rope and considerable expense was involved in replacement and loss of output.

To prevent such occurrences and to help you to get fair and safe life from your wire ropes we have compiled and published a series of papers *"Give Your Ropes a Chance"* which contains a great deal of useful and interesting information. We will be pleased to send you copies on request.

MARTIN BLACK

WIRE ROPES

MARTIN, BLACK & CO. (WIRE ROPES) LTD.,

SPEEDWELL WORKS, COATBRIDGE, GLASGOW. ... ... Telephone : COATBRIDGE 567 (Priv. Exch.)

"NUMBER TWENTYFIVE," CURTAIN ROAD, LONDON, E.C.2. ... ... Telephone : BISHOPSGATE 6667/8/9
31 N. JOHN STREET, LIVERPOOL, 2. ... ... Telephone : CENTRAL 0924 (2 lines)
640 WOODBOROUGH ROAD, MAPPERLEY, NOTTINGHAM. ... ... Telephone : NOTTINGHAM 64397 and 66055 6
13 SANDHILL, QUAYSIDE, NEWCASTLE-ON-TYNE. ... ... Telephone : NEWCASTLE 2-1282
THE EXCHANGE, MOUNT STUART SQUARE, CARDIFF. ... ... Telephone : CARDIFF 32162

ALSO : MARTIN, BLACK WIRE ROPES (CANADA) LTD., 2082 ALBERT STREET, MONTREAL 3, AND 285 BERING AVENUE, TORONTO 18.

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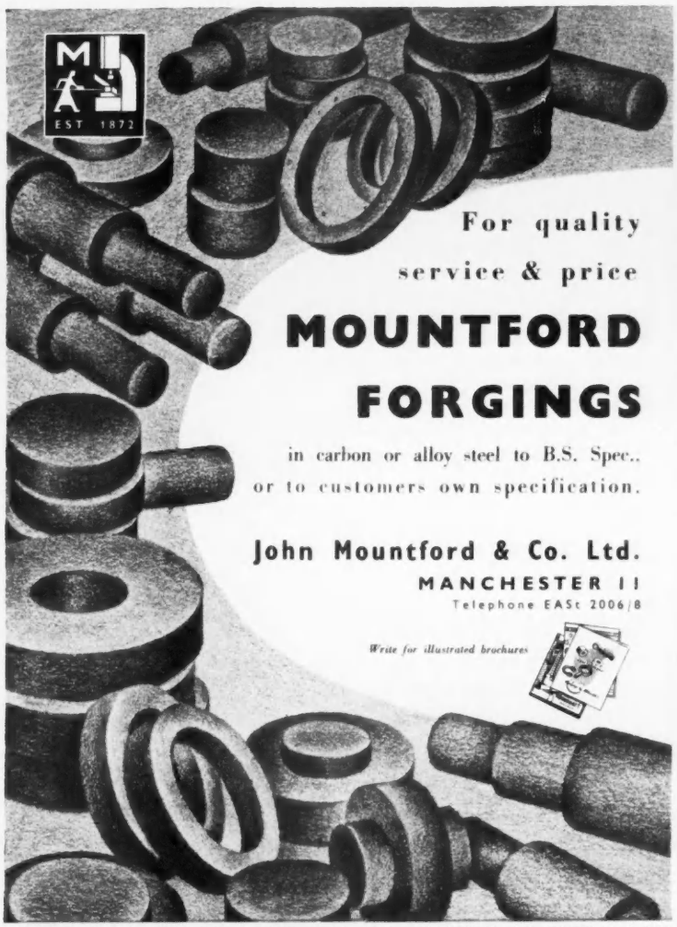

INCLUDED ON LLOYDS, ADMIRALTY AND MINISTRY OF SUPPLY LISTS

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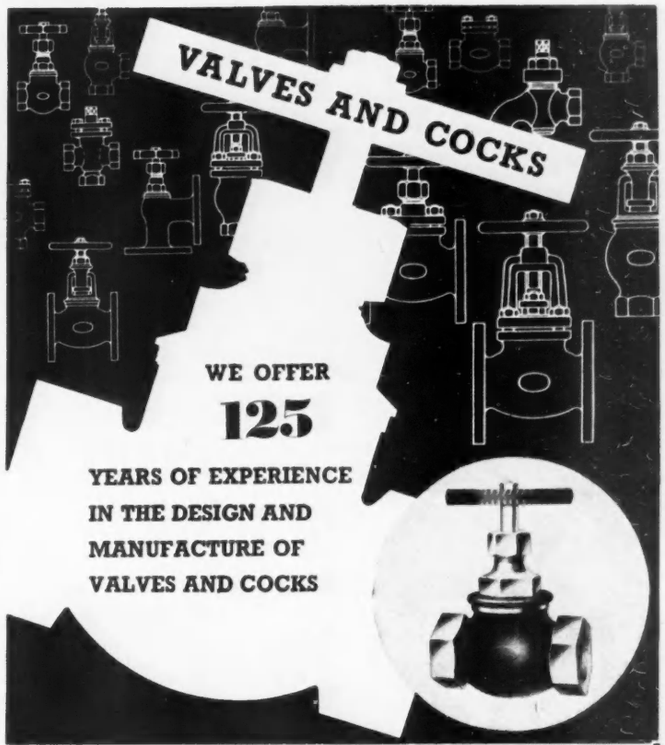

New 150 page catalogue available

ROBERT HARLOW & SON LIMITED

HEATON NORRIS, STOCKPORT, CHESHIRE

Telephone: STOckport 3403/4/5

LONDON OFFICE: 10 Norfolk Street, W.C.2

Telephone: COVent Garden 0315/6/7

CW 2538

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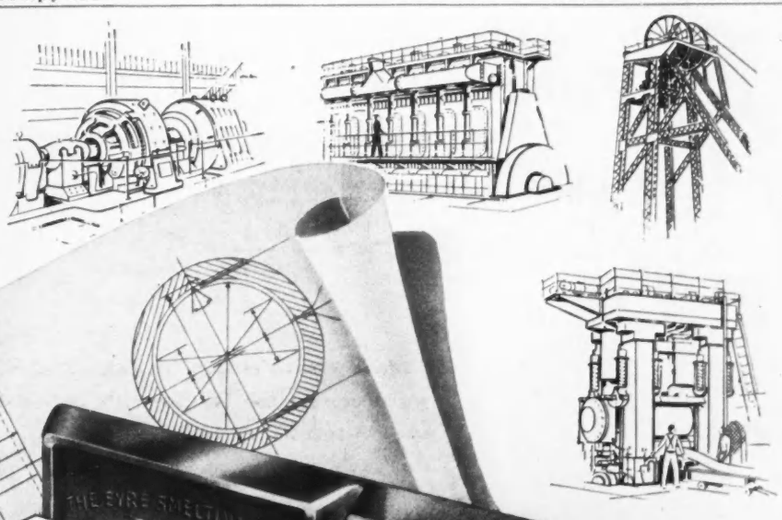
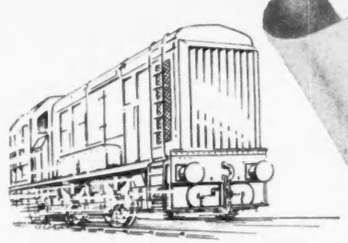
Everything depends on

BEARINGS





Widely used for the bearings of Diesel Engines, Road Vehicles, Locomotives, Generating Plant, Rolling Mills, etc.

Full details sent on request.

THE **EYRE** SMELTING CO. LTD.

THE MAKERS OF ARIEL AND ESCO PHOSPHOR BRONZE RODS

TANDEM WORKS, MERTON ABBEY, LONDON, S.W.19 Tel: Mitcham 2031 • ALUMINIUM WORKS, WILLOW LANE, MITCHAM, SURREY Tel: Mitcham 2249

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absterge

(to clean by wiping)

Austins supply the best cleaning rags for every purpose. Some jobs call for coarse, heavy fabric, some for soft, closely woven materials—we can meet all requirements with carefully selected rags that are thoroughly washed and sterilised in our own plant. Orders of all sizes are handled with promptness and reliability. Please let us quote you for regular supplies.

AUSTINS industrial cleaning rags

E. AUSTIN & SONS (LONDON) LTD., GUN WHARF, GUNMAKERS LANE, E.3 · Tel: ADVance 1211

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Plenty Tough!

Specialists in the manufacture of Castings in Manganese Bronze ; Phosphor Bronze ; Gun Metal ; Brass and Aluminium.

SPECIAL ALLOYS TO SPECIFICATION

When you need tough castings . .

CHOOSE HUGHES

J. & J. HUGHES LTD., Albion Metal Works Woodcock Street, Birmingham, 4.

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The KEY to a good replacement floor topping

—a mechanically prepared existing sub-surface

by the METTEXTURE PROCESS

Superseding slow and inefficient methods of hand hacking.

Saving time and materials.

Minimising interruption to factory routine and road traffic.

The METTEXTURE SERVICE includes EQUIPMENT and OPERATORS

It PAYS to know about The Mettexture Process

THE METROPOLITAN CONSTRUCTION CO LTD

GREENWICH HOUSE, 11, NEWGATE ST., LONDON, E.C.1. Tel. City 1488

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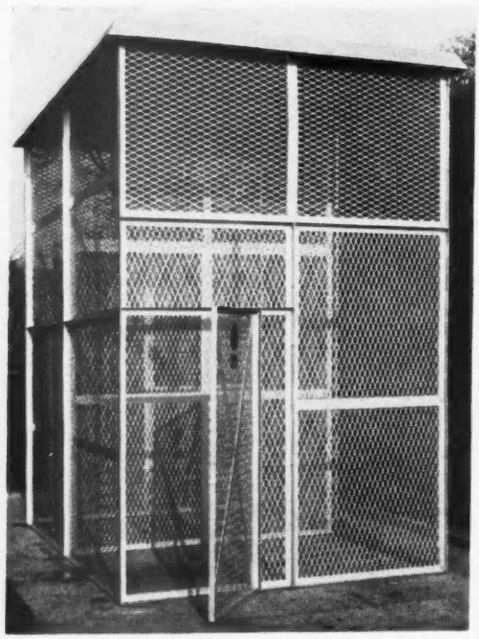
Fabrication? take my advice — see Spencers!

"Every time we've had a fabrication problem, we've put the baby on Spencer's lap – and somehow, out of the breadth of their experience, they've always turned up with the answer.

"They have a quick grasp of essentials and a profound knowledge of all kinds of fabrications in mild or stainless steel and in light alloys.

"There's no doubt about it, for this class of work you'll find Spencer's hard to beat."



Typical of the scope of Spencer's service to industry is this kiosk for electrical installations built for a leading electrical engineering concern.

SPENCER & SONS
(MARKET HARBOROUGH) LTD.

Fabrications in Steel and light Alloys

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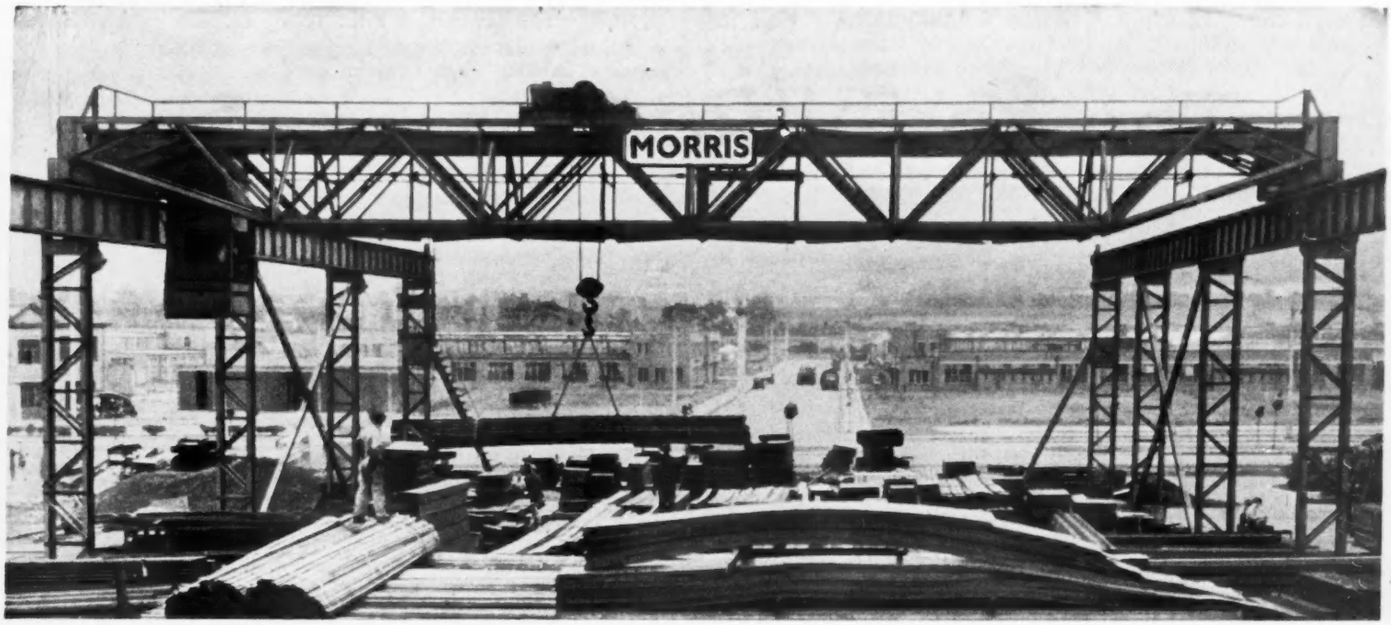

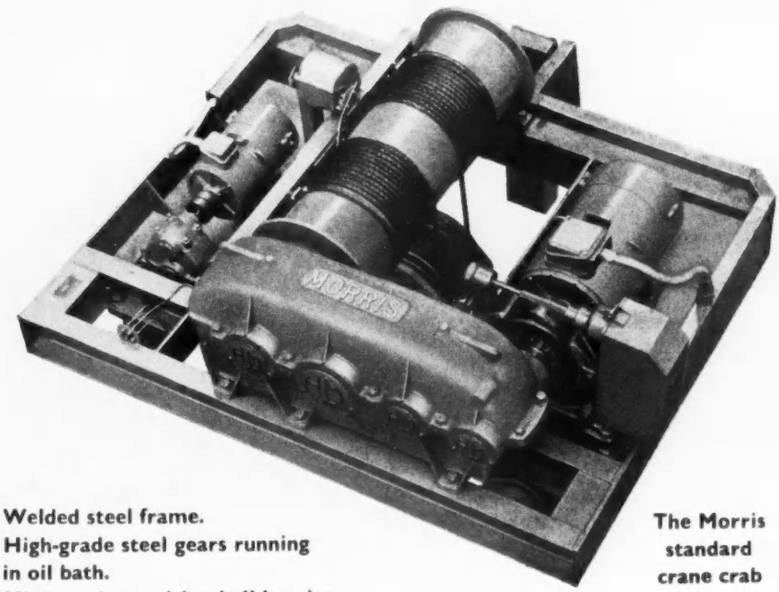

Welded steel frame.
High-grade steel gears running in oil bath.
High-grade precision ball-bearing.
Centralized grease gun lubrication.
Robust electro-mechanical brake.

The Morris standard crane crab

MORRIS
ALL-BRITISH CRANES

To meet the ever-increasing demand for early delivery of electric cranes and due to standardization of components

WE CAN NOW DELIVER

IN 8 TO 12 WEEKS,

CRANES
UP TO 10 TONS CAPACITY

(Maximum span 2 tons—60ft to 10 tons—49ft)

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FOREMOST FOR SAFETY—SINCE 1884

WHY TAKE A CHANCE? INVEST IN A MORRIS AND BE SURE

HERBERT MORRIS LTD P.O. Box 7 LOUGHBOROUGH ENGLAND.

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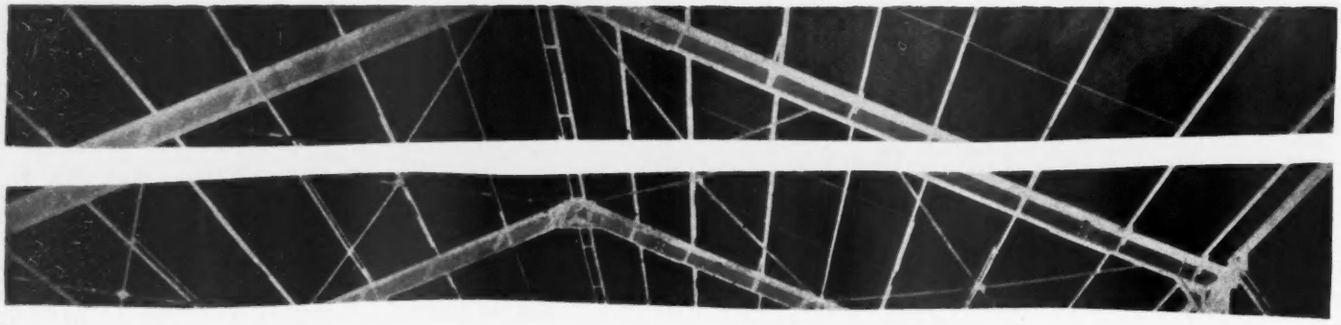
The Portal Roof...

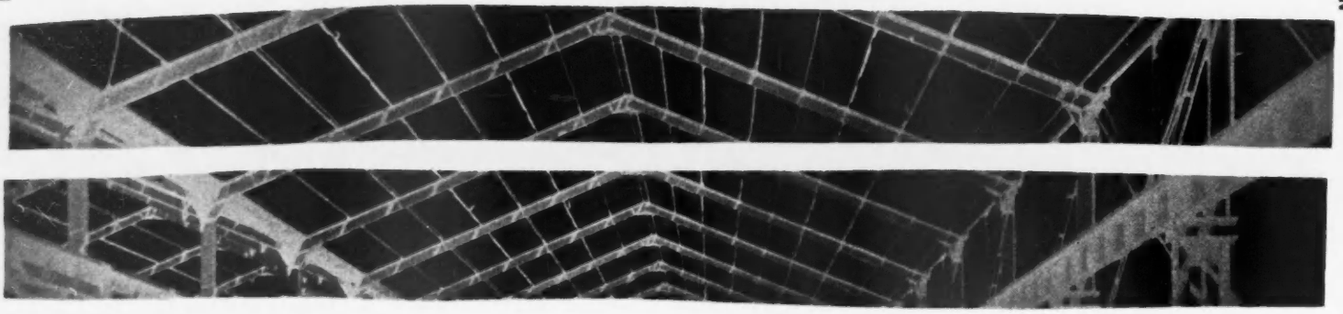


. . modern construction for the modern factory . . . .

Ever in the forefront of modern development, Lambhill show this example of a welded Portal Roof—a twin—span construction with spans measuring 70 ft. by 500 ft. giving maximum unobstructed headroom. There are no members below the rafter line to accumulate dust and dirt; the construction permits easy complete insulation. Maintenance costs are low.

DESIGN · FABRICATION · ERECTION

DESIGN · FABRICATION · ERECTION



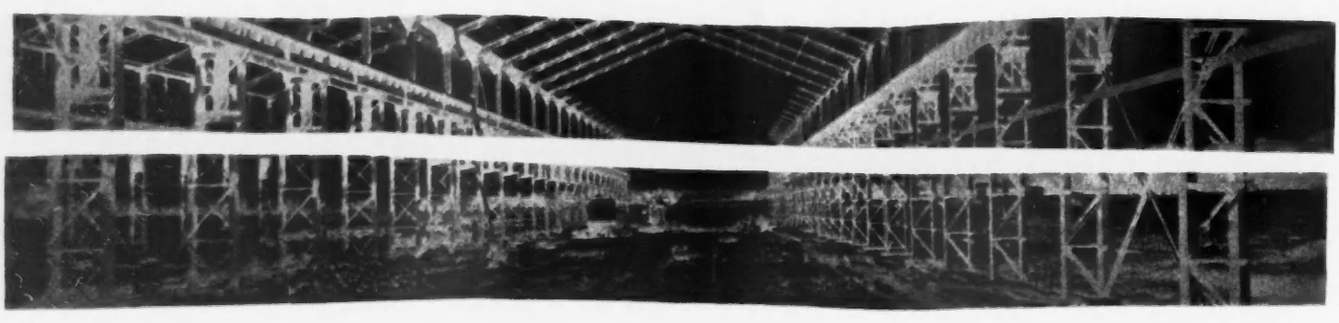
DESIGN · FABRICATION · ERECTION

DESIGN · FABRICATION · ERECTION

LAMBHILL
IRONWORKS LIMITED

HEAD OFFICE: LAMBHILL, GLASGOW. N.2.
Telephone: POSSIL 8386/7/8 *Telegrams*: "ERECTIONS" Glasgow
ALSO AT: LONDON NEWCASTLE AND SHEFFIELD

CONSTRUCTION



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CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and pro rata. 12 lines to 1 inch. There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and pro rata. 12 lines to 1 inch. There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

WELSH COLLEGE OF ADVANCED TECHNOLOGY, CATHAYS PARK, CARDIFF

Principal: A. HARVEY, Ph.D., B.Sc., F.Inst.P.

APPOINTMENTS

Applications are invited for the following posts:—

READER IN MECHANICAL ENGINEERING

The candidate appointed will have as primary responsibility the initiation and supervision of research work.

SENIOR LECTURER IN MECHANICAL ENGINEERING

Applicants should be University graduates in Mechanical Engineering and have had adequate industrial experience.

SENIOR LECTURER IN PRODUCTION ENGINEERING

Applicants should be at least Corporate Members of the Institution of Mechanical Engineers and of the Institution of Production Engineers, and have had substantial industrial experience.

SENIOR LECTURER IN ELECTRICAL ENGINEERING

Applicants must be graduates with suitable industrial and/or research experience. The successful applicant will be required to teach to the standard of Part III I.E.E. and Dip.Tech.(Eng.) and to develop research.

Salary Scales (Men): Reader, £1800 by £50 to £2100; Senior Lecturer, £1550 by £50 to £1750; Lecturer, £1370 by £35 to £1550.

Members of staff of the College are encouraged to undertake research and consultative work.

Further particulars and forms of application, which should be returned as soon as posible, may be obtained from the Principal.

ROBERT E. PRESSWOOD,
Clerk to the Governors.

City Hall,
Cardiff. E7534

NEW SOUTH WALES DEPARTMENT OF TECHNICAL EDUCATION

AUSTRALIA

ELECTRONICS: TEACHER OF INDUSTRIAL ELECTRONICS

Applications are invited for appointment to the above position.

Salary: Non-Graduate, £A1278 range £A1648, with further progression to £A1738.

Graduate, £A1343 range £A1713, with further progression to £A1778.

Commencing rate according to qualifications and experience.

Sound industrial electronics practical experience and associated theoretical knowledge required. Degree, diploma or appropriate certificate an advantage.

To assist in training men for installing, maintaining, repairing and servicing electronic devices and equipment and electronically controlled machinery.

Subject to passing a medical examination, successful applicant will be eligible to contribute to the State Superannuation Fund.

First-class ship fares to Sydney of the appointee, his wife, and children under the age of 18 years, will be paid.

Four copies of applications (including the names of two referees) and a recent photograph, should be lodged with the Agent General for New South Wales, 56, Strand, London, W.C.2, by the 6th November, 1959. E7503

UNIVERSITY OF BRISTOL

LECTURESHIP

Applications are invited for a LECTURESHIP (Grade II) in AERONAUTICAL ENGINEERING. Applicants should have a good Honours Degree and some relevant research or teaching experience, preferably in the field of High Speed Flow.

The salary will be in the range £900–£1300 (bar) to £1650. The appointment will be made as soon as possible and the successful candidate will be required to take up duty not later than 1st January, 1960.

Applications, including the names of two persons to whom reference may be made, should be sent to the Registrar, The University, Bristol, 8, from whom further particulars may be obtained. E7535

PUBLIC APPOINTMENTS

LONDON COUNTY COUNCIL

WESTMINSTER TECHNICAL COLLEGE, VINCENT SQUARE, S.W.1

APPOINTMENTS

Required, 1st January, 1960, or as soon after as possible.

1. DEPARTMENT OF CIVIL ENGINEERING
SENIOR LECTURER; subjects to include Strength and Properties of Materials and Engineering Metallurgy. Must be Graduate with good industrial and full-time teaching experience.

2. DEPARTMENT OF MECHANICAL AND GAS ENGINEERING
TWO ASSISTANTS, Grade B, for Mechanical Engineering subjects; preferably Graduates or with equivalent qualifications. Experience in industry desired. For one post, ability to assist also with Physics (Light and Sound and Elementary Electricity) an advantage.

Burnham (F.E.) Salary Scale (men): (1) Senior Lecturer, £1550 by £50 to £1750; (2) Assistant, Grade B, £700 by £27 10s. to £1150, plus possible additions for qualifications and training; increments within scale for experience. London allowance in each case £38 or £51.

Application forms from Secretary at College, to be returned by 23rd October, 1959. (2129) E7518

SURREY EDUCATION COMMITTEE

KINGSTON TECHNICAL COLLEGE, FASSETT ROAD, KINGSTON-UPON-THAMES

APPOINTMENTS

Required for 1st January, 1960:

(1) LECTURER IN MECHANICAL ENGINEERING to specialise in Theory of Structures.

(2) ASSISTANT GRADE "B" IN MECHANICAL ENGINEERING.

Candidates should have industrial experience, teaching experience desirable, and they should be Graduates or possess equivalent professional qualifications. Salary in accordance with Burnham Technical Scales. London Allowance payable.

Further particulars and application form on receipt of stamped, addressed envelope, from the Principal, to be returned as soon as possible. E7525

QUEEN'S UNIVERSITY OF BELFAST

RESEARCH ASSISTANT

A RESEARCH ASSISTANT with special interest in Electronics or Fluid Mechanics is required for work in the Hydraulics Laboratory. Current research projects include the development of apparatus for measurement of turbulence in water and study of shear flow in water channels.

Salary £300–£500 per annum according to qualifications and experience. The Research Assistant will be encouraged to work for higher degree.

Applications should reach the Professor of Civil Engineering not later than 31st October, 1959. E7536

UNIVERSITY OF LONDON KING'S COLLEGE

LECTURER IN ELECTRICAL ENGINEERING

The College will require on 1st January, 1960, or as soon after as possible, a LECTURER IN ELECTRICAL ENGINEERING. Honours degree essential. Principal requirement an ability to teach rotating machine theory and design; an interest in servo-mechanisms an advantage.

Salary scale: £900 by £50 p.a. to £1350; then, after review, by £75 p.a. to £1650. Starting point according to age and experience. In addition a London allowance, family allowances and F.S.S.U. benefits will be payable.

Full conditions of appointment and application forms may be obtained from the Registrar, King's College, London, Strand, W.C.2; completed forms must reach him by October 31st. E7502

PUBLIC APPOINTMENTS

UNIVERSITY OF CAPE TOWN, SOUTH AFRICA

LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the above post.

The salary scale is £1340 by £60 to £1760 per annum.

Applications (with copies of testimonials) should state age, qualifications, experience and research work completed or in progress and give the names of two referees whom the University may consult.

Two copies of the application and testimonials should reach the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1 (from whom memoranda giving the general conditions of appointment and further information about the work of the department should be obtained), not later than 12th November, 1959. An additional copy should be sent direct by air mail to the Registrar, University of Cape Town, Private Bag, Rondebosch, Cape Town, South Africa, by the same date.

The University reserves the right to appoint a person other than one of the applicants or to make no appointment. E7562

UNIVERSITY OF QUEENSLAND

LECTURER IN CIVIL ENGINEERING

Applications are invited for the above position. Applicants must hold a Degree in Civil Engineering (preferably an Honours Degree) and have had some experience in the design and construction of engineering works. Experience in lecturing and research work is desirable but not essential. Experience in Hydraulic laboratory work would be an advantage. The appointee will be required to take part in either structural or hydraulic laboratory work and field investigations and to supervise senior work.

Salary: £A1540/£A2040 per annum.

Further particulars may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close in Australia and London on 27th November, 1959. E7563

MINISTRY OF SUPPLY

FARNBOROUGH

TECHNICIAN

Ministry of Supply requires a TECHNICIAN at Farnborough, to assist in supervision of skilled personnel engaged in manufacture of precision wind tunnel models and their associated jigs, fixtures, &c. A period of service in the Planning Office may be required.

Qualifications: Recognised engineering apprenticeship; O.N.C., C. and G. Finals, or equivalent. Fully conversant with methods and techniques used in manufacture of highly accurate aerofoil sections in high-tonnage steels, light alloys, &c. Knowledge of heat-treatment requirements for these materials an advantage.

Salary: £680 (age 26) to £850 per annum.

Application forms from Manager (P.E.2331), M.O.L. and N.S., Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4. E7558

BRITISH TRANSPORT DOCKS

DOCK ENGINEER'S DEPARTMENT, HULL DOCKS

TECHNICAL ASSISTANT

British Transport Docks invite applications for the position of TECHNICAL ASSISTANT in the Dock Engineer's Department, Hull Docks.

Applicants should have experience in design of dock and harbour structures and preparation of specifications and bills of quantities. Supervision of Drawing Office staff. Commencing salary £943 per annum, contributory superannuation scheme and certain rail travel facilities.

Applications, giving age, experience and present position, should be forwarded to: Chief Docks Manager, P.O. Box No. 41, Dock Office, Victoria Square, Hull, to arrive not later than Friday, 16th October, 1959. E7519

PUBLIC APPOINTMENTS

CITY AND COUNTY OF BRISTOL

APPOINTMENT OF MECHANICAL AND ELECTRICAL ENGINEER

A.P.T. GRADE V (£1220 TO £1375)

Applications invited from qualified Mechanical and Electrical Engineers for above post.

Applicants must be Associate Members of the Institution of Mechanical Engineers and/or Associate Members of the Institution of Electrical Engineers, or possess a Degree in Mechanical and/or Electrical Engineering obtained at a British University.

Applicant must be capable of preparing design and specifications for Mechanical and Electrical equipment associated with construction of large pumping stations and a new sewage disposal works for treatment of a dry weather flow of 42 million gallons per day.

Post permanent and pensionable; medical examination; probationary period of six months, except in case of officer transferred from service of another Local Government Authority.

Housing needs of successful candidate and question of a contribution towards removal expenses favourably considered.

Applications, stating age, nationality, educational training, professional qualifications, present and previous positions, with salaries and dates, notice required to terminate present appointment, whether related to a member or senior officer of the Council, and names of two referees, to City Engineer, Cabot House, Deanery Road, Bristol, 1, by 26th October, 1959.

Canvassing disqualifies. E7543

CITY OF BRADFORD

ENGINEERING ASSISTANTS

Applications are invited for the following superannuable appointments in the City Engineer and Surveyor's Department, on the grades indicated.

(a) SENIOR ENGINEERING ASSISTANT, Post 13, Special Grade (£785–£1070).

(b) ENGINEERING ASSISTANTS, Posts 37 and 120, Grade A.P.T. I or Special (£610–£765 or £785–£1070).

(c) JUNIOR ENGINEERING ASSISTANTS, Posts 52 and 63, Grade A.P.T. I (£610–£765).

Applicants for (a) should preferably hold an Engineering Degree, be A.M.I.C.E./A.M.I.Mun.E., and have had a good general civil engineering training.

Applicants for (b) should have completed their professional training. Salary on Special Grade will be payable to the successful candidates holding an Engineering Degree or A.M.I.C.E./A.M.I.Mun.E.

Applicants for (c) should have completed their professional training and have had experience in Municipal and/or Civil Engineering.

Applicants should have completed their National Service. No housing accommodation can be provided by the Corporation.

Applications, on forms to be obtained from the City Engineer and Surveyor, Town Hall, Bradford, 1, together with three testimonials, must be received by the undersigned by 2nd November, 1959.

W. H. LEATHEM,
Town Clerk.

Town Hall,
Bradford, 1. E7561

CIVIL SERVICE COMMISSION

CIVIL, STRUCTURAL AND PUBLIC HEALTH ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on 1st January, 1959 (extension for regular Forces service, Overseas Civil Service, established civil service and temporary Government service, as Civil, Structural or Public Health Engineer). Candidates must have achieved Corporate Membership of an appropriate professional Institution or have passed examinations necessary for attaining such membership. Some posts require qualifications in certain subjects.

Starting salary (men, London) from £830 to £1125, according to age. Scale maximum (London) £1300. Promotion prospects.

Write, Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S64–66. E7557

Classified Advts. continued on page 138

PUBLIC APPOINTMENTS

ATHERSTONE RURAL DISTRICT COUNCIL

DISTRICT WATER SUPPLY—CONTRACT NO. 2

APPOINTMENT OF RESIDENT ENGINEER

Applications are invited for the above appointment to supervise the following works, under the direction of the Council's Consulting Engineers, J. D. and D. M. Watson, MM.I.C.E., Chartered Civil Engineers, 67, Tufton Street, Westminster, S.W.1.

The construction of one 42,000 gallon reinforced concrete reservoir, one new building and extensions and alterations to one existing building to house treatment plant, one booster station, the sinking of one borehole and the cleaning out and lining of two existing boreholes, the installation of two water treatment plants, three automatic electrically controlled submersible borehole pumping sets and booster plant, and the construction of about 14½ miles of asbestos cement mains, including fittings and service connections.

The salary offered is £1200 per annum and the appointment will be terminable by 2 months' notice on either side and will be subject to satisfactory service.

It is expected that the works will commence during December, 1959, and will take 18 months to complete.

A car mileage allowance will be paid on the Essential User scale.

Applicants, who should be Associate Members of the Institution of Civil Engineers, or have comparable qualifications, and must have had experience of similar work, should apply in writing to the undersigned not later than 26th October, 1959, giving full particulars of age, qualifications and experience and enclosing copies of not less than two recent testimonials.

G. CARLYON MAY,
Clerk of the Council.

Council Offices,
Atherstone,
Warwickshire.
September, 1959. E7467

SOMERSET COUNTY COUNCIL

WELFARE SERVICES COMMITTEE

FOREMAN ENGINEER

FOREMAN ENGINEER required, to take complete charge, through the Superintendent, of the engineering equipment at Cambrook House, Clutton, Nr. Bristol (Welfare Services Institution—130 beds), and act as Foreman in Charge of the Engineering and Maintenance Staff.

The equipment includes three oil-fired steam boilers (one horizontal Paxman Ultronomic and two vertical smoke-tube boilers) and steam-operated laundry and kitchen equipment, central heating and hot water supply plant.

Candidates should hold Ordinary National Certificate in Mechanical Engineering (including heat and engines), preferably with an endorsement in the principles of electricity, or equivalent certificate, and have practical mechanical and electrical training and experience. Consideration will be given to persons who have completed a Royal Naval Mechanical Training Course.

The person appointed will be required to supervise engineering equipment in a limited number of small old persons' Homes near Clutton.

Salary: £610 by £30 to £765 per annum.

Application forms and further particulars may be obtained from the County Welfare Services Officer, County Hall, Taunton. E7545

MINISTRY OF SUPPLY

BURGHFIELD, BERKS

TECHNICIANS

Ministry of Supply requires TECHNICIANS at Burghfield, Berks, to assist in inspection and assembly of components made to fine limits. Work involves high-explosive and various other materials.

Qualifications: Recognised engineering apprenticeship; O.N.C., C. and G. Finals, or equivalent. Experience of gauge or tool-room inspection, metrology, high-explosive work, and knowledge of inspection procedure an advantage.

Salary: £850 (age 30) to £1005 per annum.

Application forms from Manager (P.E.2330), M.O.L. and N.S. Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4. E7559

TENDERS

GOVERNMENT OF NEW ZEALAND

MINISTRY OF WORKS

WAIRAKEI GEOTHERMAL PROJECT

"B" STATION BUILDING STEELWORK AND WALL CLADDING

TENDERS will shortly be invited for the SUPPLY only of FABRICATED STEELWORK and WALL CLADDING for the "B" Station at Wairakei.

This will consist of steel main and secondary box portal frames, steel roof lattice girders, wall and floor members of rolled steel sections, cladding of aluminium alloy curtain-walling and sheeting (with insulation board). The approximate quantity of steelwork is 600 tons.

Firms who are interested should apply to Merz and McLellan, Milburn, Esher, Surrey, for further particulars. No further announcement will appear in the press and manufacturers should regard this notice as the formal invitation to Tender. E7516

TENDERS

NATO COMMON INFRASTRUCTURE

SLICES VII AND VIII

NAVAL BASE INSTALLATIONS

Final Notice is hereby given that International Competitive BIDS will be invited on or about 9th December, 1959, for the CONSTRUCTION of a P.O.L. STORAGE DEPOT in the Loch Striven area of Scotland.

2. The approximate total value of the works is £3,000,000 and the contract will comprise :—

(i) The SUPPLY and CONSTRUCTION of SEMI-BURIED STEEL STORAGE TANKS and ASSOCIATED PIPELINE.

(ii) The PROVISION and INSTALLATION of PUMPS, BOILERS, STEAM HEATING, ELECTRICAL GENERATING PLANT and DISTRIBUTION SYSTEMS.

(iii) The CONSTRUCTION of ROADS and FOOTPATHS and MISCELLANEOUS BUILDINGS.

(iv) The CONSTRUCTION of a DEEP WATER JETTY with off-loading facilities.

3. Separate Final Notices will be issued in respect of the Specialist Steam, Pumping and Electrical Equipment and Electrical Installation work which are to form the subjects of sub-contracts within the above main contract.

4. It should be noted that the importation of labour from sources outside the United Kingdom may be subject to restriction and that permission could, in any case, only be given on an undertaking that the Contractor would pay rates of wages and observe hours and conditions of labour not less favourable than those established for U.K. labour for the trade or industry in the same area.

5. The closing date for the receipt of Bids will be 2nd March, 1960.

6. Firms wishing to be invited to Bid must formally notify their desire by application to the address below by 4th November, 1959.

7. Within one week of the closing date for the receipt of applications to Bid, firms wishing to be invited must forward the following information :—

(i) Statement of financial resources and evidence of financial stability.

(ii) Details of recent major contracts completed for work of a comparable nature, including an indication of the value of each.

8. Enquiries regarding Bidding should be addressed to :—

Civil Engineer-in-Chief,
Admiralty,
Chamberlain Way,
Pinner,
Middlesex,
England,

quoting reference C.E. in C./INFRA/9. E7551

INDIA STORE DEPARTMENT

STAINLESS STEEL CLAD PLATES

The Director General, of India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the supply of :

	Quantity Nos.
STAINLESS STEEL CLAD PLATES, ¾in. thick, cut and machined to various sizes	100

Forms of tender may be obtained from the above address on or after the 9th October, 1959, at a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to "High Commissioner for India." Tenders are to be delivered by 2 p.m. on Thursday, 12th November, 1959.

Please quote reference No. 24/59/RLY. E7533

COQUET WATER BOARD

WARKWORTH INTAKE WORKS

Civil engineering contractors are invited to TENDER for the construction of the intake works on the River Coquet near Warkworth which comprise :

A pool type reinforced concrete FISH PASS at Coquet Lodge Weir, 300ft. long and 15ft. wide, founded on piles, which embodies the main intake itself and a recirculation water outfall ;

A RECIRCULATION WATER INTAKE at a point some ¼-mile downstream ;

A 30in. RECIRCULATION WATER PIPELINE about ½ mile long ;

The erection of a CONTROL GATE on an existing fish pass ;

TWO PONDING WEIRS about 200ft. long, in the River Coquet downstream of the recirculation water intake.

Tender documents will be ready for issue towards the end of October and the tenders will be returnable towards the middle of December. Contractors who are desirous of tendering should send an application with a deposit of £5 to the Engineers : Sir William Halcrow and Partners, 47, Park Lane, London, W.1.

The deposit will be returned on receipt of a bona fide tender.

The Board is not bound to accept the lowest or any tender.

F. G. EGNER,
Clerk and Solicitor.

The Coquet Water Board,
14, Northumberland Square,
North Shields. E7459

INDIA STORE DEPARTMENT

ELECTRIC HOISTS

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

TENDER REF. No. 20045/59/ACR/HAL

ELECTRIC HOISTS—with Hand-operated Geared/Power-Driven Trolley—5 cwt. to 7½ tons capacity—61 off.

The Tender forms with schedules and specifications, which are returnable on 9th November, 1959, may be obtained from the above office (CDN Branch) on payment of a fee of ten shillings (not refundable) for each Tender.

The applications for Tenders should clearly state the above reference number. E7517

TENDERS

MINISTRY OF TRANSPORT AND CIVIL AVIATION

HEADS OF THE VALLEYS ROAD

SECTION 1. BRYNMAWR TO ABERGAVENNY

The Minister of Transport and Civil Aviation invites TENDERS for the CONSTRUCTION of a NEW SINGLE CARRIAGEWAY ROAD, approximately 7¼ miles in length ; together with twelve REINFORCED CONCRETE BRIDGES (one of which is of post-tensioned in-situ pre-stressed construction ; five REINFORCED CONCRETE SUBWAYS ; RETAINING WALLS ; RIVER DIVERSION and TRAINING WORKS ; COMMON and ROCK EXCAVATION in TRENCHES and CUTTINGS and EARTHWORK in EMBANKMENTS ; and incidental works.

Contract documents may be obtained from the Consulting Engineers, Messrs. Rendel, Palmer and Tritton, 125, Victoria Street, Westminster, S.W.1, on payment of a deposit of £25 by cheque or draft payable to the order of the Minister of Transport and Civil Aviation. The deposit will be returned if a bona fide tender is submitted and not subsequently withdrawn.

The contract documents and drawings of the proposed works may be inspected at the offices of the Consulting Engineers, before payment of the deposit. Tenders on the official form are to be sent, by registered post or by hand, in sealed envelopes plainly marked "Tender for Heads of Valleys Road (Section 1)," addressed to the Assistant Secretary, Highways Management and Services Division, Ministry of Transport and Civil Aviation, 21–37, Hereford Road, London, W.2, to arrive not later than 4 p.m. on Wednesday, 2nd December, 1959.

The Minister does not bind himself to accept the lowest or any tender.

H. GILLENDER,
An Assistant Secretary.

E7540

EDUCATIONAL

BATTERSEA COLLEGE OF TECHNOLOGY, LONDON, S.W.11

A course of five lectures on "The Production and Uses of Diffraction Gratings," will be held on Monday evenings at 7 p.m., commencing on November 9th. Emphasis will be given to the recent developments in grating production, and the use of gratings in measurement and automatic machine-tool control.

Further details and enrolment forms obtainable from the Secretary (Spectroscopy Courses). E7565 E

U.K.A.E.A.

HARWELL REACTOR SCHOOL

Control and Instrumentation of Reactors Course

The third course on "The Control and Instrumentation of Reactors" will be held at Durley Hall, Bournemouth, Hampshire, from the 1st to 12th February, 1960, inclusive.

The fourth course will also be held at Durley Hall, Bournemouth, Hampshire, from the 23rd May to the 3rd June, 1960, inclusive.

The fee for either course will be fifty guineas exclusive of accommodation.

Application forms and further details can be had from :—

The Principal,
Reactor School,
Atomic Energy Research Establishment,
Harwell,
Didcot,
Berks.

E7531 E

U.K.A.E.A.

HARWELL REACTOR SCHOOL

Standard Course No. 20

The next Standard Course will be held from the 4th January to 29th April, 1960, inclusive. The fee for the course is £250 exclusive of accommodation.

Senior Technical Executives' Course No. 10

The course will be held from the 9th to 20th May, 1960, inclusive. The fee for the course is fifty guineas exclusive of accommodation.

Application forms and details for both courses can be obtained from :—

The Principal,
Reactor School,
Atomic Energy Research Establishment,
Harwell,
Didcot,
Berks.

E7530 E

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

ASSISTANT CHIEF DRAUGHTSMAN required by expanding Company in Surrey approximately 25 minutes from Waterloo. Successful applicant should be experienced in the design of small mechanisms, &c., be a good disciplinarian, and in view of the specialised nature of the product will be expected to make his career with the Company. Minimum qualification of H.N.C., but men with experience and a sound background who are not so qualified will be considered.—BOX No. E169, "The Engineer." A

B.P. has a vacancy for a MECHANICAL ENGINEER in BAHRAIN. He should have served a full engineering apprenticeship and have experience in one or more of the following fields : pumps and pumping installations ; liquid meters ; marine engineering ; aircraft fuelling ; road transport maintenance. Previous experience in the oil industry would be an advantage. Age range preferably 30–35. Qualifications at least H.N.C. or equivalent. He will be required to take charge of the technical aspects of the B.P. Aviation Service in the Persian Gulf Area. This includes supervision of the maintenance of all aircraft refuelling facilities. Free passage out and home, free medical attention. Kit allowance. Pension scheme, good leave arrangements.—Write, with full particulars, quoting F.575, to BOX 3183, c/o 191, Gresham House, E.C.2. E7521 A

BRITISH-AMERICAN TOBACCO COMPANY LIMITED

require a

FACTORY ENGINEER

for service with an associated company in West Africa. Applicants up to 35 years of age, should possess G.I.Mech.E. or equivalent qualifications. Salary according to age and experience, free passages and furnished accommodation provided. Posts are pensionable and offer good permanent prospects to qualified engineers with practical Engineering experience.

Apply in writing, giving full details of age and career, to Personnel Dept. (No. 11), British-American Tobacco Company, Ltd., Westminster House, 7, Millbank, S.W.1. E7553 A

CHIEF ENGINEER.—With experience in modern tankers, required immediately for an air-conditioned 25,000 d.w.t. British flag new building, Burmeister and Wain eight cylinder, two stroke, supercharged diesel engine. Successful applicant will be required to stand by in Belgium whilst the engine is being installed. Apply in writing, giving particulars and references, to : Hector Whaling, Ltd., 41, Upper Grosvenor Street, London, W.1. E7542 A

COLGATE-PALMOLIVE LIMITED

Manchester,

invite applications from

DESIGNER-DRAUGHTSMEN

at H.N.C. level, preferably with some experience of plant layout and design. Work is interesting and varied, under ideal conditions, and a good salary will be paid to the right man.—Applications, giving details of age, salary expected, training, qualifications and experience, should be sent to Factory Personnel Manager, 371, Ordsall Lane, Salford, 5. E7552 A

CONTRACTING ORGANISATION of national repute requires SENIOR CIVIL ENGINEERING ESTIMATOR. Operate from Midlands office. Must have proven record of ability in similar capacity. This appointment carries excellent salary and conditions. Pension and bonus schemes in operation. Progressive position for right man.—Write, BOX No. DL.5450, c/o Whites, 72, Fleet Street, London, E.C.4. E7505 A

DESIGN AND DEVELOPMENT ENGINEER required, with experience in medium and high pressure hydraulic pumps and controls. Excellent prospects in a new department for the right man, together with a four-figure salary. Reply, giving full details of experience.—BOX No. E2566, "The Engineer." A

DESIGN ENGINEERS H.N.C. (Min.) required. Experience in one or more of the following essential : Cranes, Excavators, Truck-mounted Mobile Cranes and Contractor's Plant. Good staff conditions. Pension scheme.—Applications in writing, all relevant particulars and approximate salary required to : Personnel Manager, Ruston-Bucyrus, Ltd., Excavator Works, Lincoln. E7473 A

DESIGN ENGINEER required with experience in heat transfer calculations and design of small compact heat exchangers.—Write, stating age, details of experience, &c., to Chief Designer, DELANEY GALLAY, LTD., Vulcan Works, Edgware Road Cricklewood, N.W.2. GLAdstone 2201. E7538 A

BOOKS & PUBLICATIONS

STRENGTH OF MATERIALS FOR ENGINEERS

By D. R. Axelrad, Dipl. Ing., etc. This new book meets the requirements of students preparing for Engineering Degree examinations and those of the professional bodies. Of value also to practising engineers, the book includes a large number of worked examples and additional problems taken from examination papers. 55/- net.

ENGINEERING METALLURGY

By the Committee on Metallurgy. Compiled by metallurgy professors, this new book presents in a concise understandable manner the principles of ferrous and non-ferrous metallurgy for all engineers—student and practising. It is an essential book for those who, while not having time to read the technical journals, wish to keep up to date with metallurgical developments. 45/- net.

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SITUATIONS VACANT

DRAUGHTSMAN, age 25/30, required by East London Chemical Works, for interesting plant development. O.N.C. standard. Experience in similar work desirable.—Write in confidence to BOX Z.B.418, Deacon's Advertising, 36, Leadenhall Street, E.C.3. E7554 A

DRAUGHTSMAN required for interesting work on design and detailing of electrical domestic products. A knowledge of mass production processes, with particular reference to press work, die-casting and moulding is necessary. Ordinary National Certificate (Mechanical) would be a desirable qualification. Age range 25–40, excellent salary, plus bonus and working conditions offered.—Apply in writing, Employment Officer, Hoover, Ltd., Perivale, Greenford, Middlesex. E7556 A

ELECTRICAL SALES ENGINEERS

Bruce Peebles and Co., Limited, East Pilton, Edinburgh, 5, require Engineers of H.N.C. Standard for their Transformer Sales and Contracts Department. 5-day week. Staff pension and bonus schemes. Housing assistance given if necessary.—Apply, giving details of experience, to Divisional Director (Transformers) at the above address. E7541 A

ENGINEER, MECHANICAL. Supervision of general maintenance, erection and dismantling Plant, &c. State salary and experience in writing to Rees Industries, Ltd., Great Western Dock, Llanelly. E2557 A

ENGINEERING DRAUGHTSMAN REQUIRED.—Experience should include plant layout; knowledge of foundry plant and mechanical handling an advantage. Preferably H.N.C., but not essential.

ARCHITECTURAL DRAUGHTSMAN REQUIRED.—Experience of general industrial buildings. Knowledge of Specifications, Bills of Quantities, &c., essential.

Both vacancies call for broad general experience, including design and detail work. Ample scope and following-up work on site.

First-class conditions, with Bonus Profit Sharing and Pension Schemes.

Applications in writing, stating full details of experience, qualifications, age, &c., salary required, to:
Works Director,
Ley's Malleable Castings Co., Ltd.,
Colombo Street,
Derby. E7524 A

ESTIMATOR required, with good general engineering background. Preference will be given to applicants with experience of pressure vessels, stainless steels and rate-fixing for welded constructions. Company situated in Medway Towns area, a pension scheme is in operation. Write.—BOX No. E2567, "The Engineer." A

HONOURS GRADUATES in Engineering and Science required for fundamental research on machine tools and manufacturing techniques. Excellent working conditions and prospects. Good commencing salary with annual increments on merit. Superannuation under F.S.S.U.—Applications to the Secretary (R.589), Production Engineering Research Association, Melton Mowbray, Leics. E7526 A

INTERMEDIATE HEATING/VENTILATING DRAUGHTSMAN required by new division of old-established firm of Electrical Engineers. Must have good all-round experience of modern heating/ventilating schemes. Good salary, conditions, progressive appointment.—Write, Personnel Manager, George E. Taylor and Co. (London), Ltd., 34, Southwark Bridge Road, London, S.E.1. E7504 A

MECHANICAL DESIGNERS for Automatic Production and assembling machines and mechanical handling of components. Varied projects require skill, enthusiasm. Good salary.—Rhoden Partners, 29, Park Crescent, W.1. LAN 7488. E7528 A

MECHANICAL ENGINEER required by the National Coal Board for their Experimental Power Plant at Rothes, Fife. Salary, according to qualifications and experience, within the range of £1050–£1600 per annum. The successful applicant will be required to carry out various tests and to supervise the operation of an experimental coal-fired gas turbine power plant at Rothes Colliery for at least twelve months. Applicants should have a Degree in Mechanical Engineering or equivalent and special knowledge of thermodynamics and heat engines. Experience of the gas turbine cycle and operation of a power plant would be an advantage. Special training, which will probably include study of Continental equipment, will be given.—Applications, stating age, education, qualifications, experience, present post and salary, to Staff Department, National Coal Board, 3, Eglinton Crescent, Edinburgh, 12. E7510 A

MECHANICAL ENGINEER.—Applications are invited from Engineers experienced in design of Petroleum and Chemical Plant, for a position in London Office of Consultants/Contractors. B.Sc. minimum qualification.—Please send full particulars of qualifications and experience to Personnel Manager, Head Wrightson Processes, Ltd., 16–26, Baltic Street, E.C.1. E7564 A

PLANNING ENGINEER required. Must have machine and Assembly Shop experience, sound knowledge of modern Jig and Tool design, operation layout and general tooling, conversant with rate fixing and cost investigation and analysis. Ability to follow up from development stage through to production—sound engineering workshop experience. Must have served apprenticeship.—Write, stating age, education, previous positions held, and salary required, and when available to: General Works Manager, Saml. Denison and Son, Ltd., Hunslet Foundry, Leeds, 10. E7405 A

REPRESENTATIVE, accustomed to the capital goods industries and with a lively interest in advertising, required by a group of old-established technical journal publishers, to sell to Engineers, Manufacturers and Advertising Agents. This is a pensionable appointment and remuneration will be on a salary and commission basis. Please state details of career, age, and if car owner.—BOX No. E7555, "The Engineer." A

RESIDENT ENGINEER required by major contracting Company for construction supervision of new Oil Refinery and Chemical plants. Must be a good administrator and able to assume complete control of civil and mechanical engineering site organisation. The successful applicant will deal with client's jobs of £5,000,000 and over. Salary up to £3000 p.a., according to experience and qualifications.—Please write, in confidence, giving full details of past employers and contracts carried out.—BOX No. E7568, "The Engineer." A

SAFETY OFFICER. A large Engineering firm specialising in the erection of heavy industrial plant and building and civil engineering construction requires the services of a SAFETY OFFICER. The post involves control of the accident prevention work on contract sites in the U.K. An engineering background is desirable and technical qualifications would be an advantage. Candidates should have had experience of safety work and must be fully acquainted with the application of the Factories Act and Statutory Regulations. Only candidates who can fulfil these requirements will be considered and a commensurate salary will be paid to the right man. An interview in confidence will be arranged with suitable candidates and full details of duties, responsibility, &c., will be explained. The post is superannuable. The successful candidate will operate from an office in the North of England, but travelling to sites is necessary. Please write full details.—BOX No. E7493, "The Engineer." A

SALES ENGINEER of Indian nationality required for subsidiary company in Calcutta. Preferably trained in water treatment, with some knowledge fan engineering. Six months' training in latter field offered with parent company before returning India. Write full particulars.—BOX No. E7520, "The Engineer." A

SALES REPRESENTATIVE required for London area by old-established company; good connections with Architects and Consulting Engineers, &c., essential; covering ironwork and structural steelwork.—BOX No. E7454, "The Engineer." A

SENIOR DETAIL DRAUGHTSMAN, O.N.C. (Min.) required. Experience in one or more of the following essential: Cranes, Excavators, Truck-mounted Mobile Cranes and Contractor's Plant. Good staff conditions, Pension scheme.—Applications in writing, all relevant particulars and approximate salary required to: Personnel Manager, Ruston-Bucyrus, Ltd., Excavator Works, Lincoln. E7474 A

SENIOR TRANSFORMER DESIGNER required by rapidly expanding company. Preferably experienced on units up to 10mVA., 66kV. Salary, £1250 to £1500 per annum.—Apply, stating age and qualifications, to Chief Designer, Denis Ferranti Co., Ltd., Royton, Oldham, Lancs. E2569 A

THE GLACIER METAL COMPANY, LTD

Invites Applications for the Post of

SENIOR RESEARCH ENGINEER

The successful candidate will work solely for the Manager of the Engineering Research Department in the Company's Research and Development Organisation. He will be responsible for keeping abreast of work carried out externally in the field of fundamental research in plain bearings and bearing applications; he will assist his Manager in assessing the commercial and research implications of application data and also carry out original research in this field; he will have to build up and lead a small team of research workers for this purpose. There are excellent career prospects.

Applicants should have an Honours Degree in Mechanical Engineering together with some practical experience and at least two years research, preferably of course, though not essentially in the field of sliding bearings or lubrication.

Salary Range: £1350 to £1750 per annum.

Applications should be sent to
Personnel Director (Ref. ERD),
Glacier Metal Co., Ltd.,
Ealing Road, Alperton, Wembley, Middlesex.

E7529 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

WANTED URGENTLY, Estimator for Materials Handling Bulk and Package, used to working on own initiative on preparation of project drawings and tenders. Residence in Nottingham. State age, experience and salary expected.—Apply BOX No. E2561, "The Engineer." A

WELDING SUPERVISOR required in Kent area, with wide experience of Stainless Steel, Copper, &c., to supervise welding of X-ray quality. Applicants should be fully conversant with pressure vessel codes of construction and able to train welders to standard required. Replies will be opened in strict confidence by the Production Engineer. Please give full details of experience and salary required.—BOX No. E7544, "The Engineer." A

WORKS MANAGER for Steel Plate and Sheet Metal Fabrication works, employing approximately 65 men. Experienced ENGINEER required with drive and initiative. Permanent progressive position. Commencing salary £1200 per annum.—Write with full details in confidence to BOX No. E2568, "The Engineer." A

Classified Advts. continued on page 140

SITUATIONS VACANT

DISTINGTON ENGINEERING COMPANY LIMITED,

Workington, Cumberland

The following vacancies arise in this large and progressive works on the edge of the Lake District :—

SENIOR ENGINEERING ESTIMATOR —must have had several years' experience as an estimator on medium/heavy general engineering work and at least five years' workshop experience. H.N.C. standard or equivalent. Preferred age 33–40.

SENIOR WELDING FOREMAN—must have specialist experience in modern welding techniques, including Class I, and with particular reference to avoidance of distortion ; also ability to carry out general foremanship supervisory duties. Products are mainly medium/heavy steel fabrications. Preferred age 28–45.

Both positions are of senior staff status, carrying excellent remuneration—according to qualifications and experience ; pension scheme ; assistance with housing is available.

IF YOU THINK YOU ARE QUALIFIED, PLEASE WRITE initially with fullest details, to the PERSONNEL MANAGER at the ABOVE ADDRESS.

E7567 A

SITUATIONS VACANT

CONTRACTS MANAGER

A Glasgow engineering company desires to appoint a Contracts Manager to take charge of a department engaged in the purchasing, progressing and inspection of subcontracted plant and machinery of substantial annual value. The scope of responsibility extends from the issue of orders to subcontractors to the completion of manufacture ready for delivery from various works throughout the U.K. In the case of "turnkey" orders, the Contracts Manager will be responsible for the erection of the plant in purchasers' factories and for the control of the outside workmen and staff engaged at site. In some instances such erection work may be necessary overseas. Candidates should have a comprehensive engineering training, possessing managerial ability in the field of activities described, and be experienced in negotiating and corresponding with companies at director level. Salary around £2000 per year. Desirable age range 45–55. Contributory pension scheme.—BOX No. E7509, "The Engineer."

A

SITUATIONS VACANT

THE APPLIED MECHANICS LABORATORY

ENGLISH ELECTRIC, STAFFORD

In view of the increasing importance of mechanical engineering in the heavy electrical engineering industry, there is an increasing need for good engineers on the staff of this Laboratory, which deals with a wide range of mechanical design, development and research problems.

Applications are invited from Senior and Junior Engineers and Technical Assistants with experience in the following fields :

Stress Analysis

Vibrations

Test Instrumentation and Transducer Development

Engineers with general mechanical engineering experience, especially those who have an aptitude for design, are also invited to apply.

It is anticipated that the senior posts will be filled by professionally qualified engineers in the age group 28 to 35. Applicants should feel capable of holding a responsible senior position and controlling the work of others. For some of the posts an aircraft engineering background will certainly be considered.

If you would like to visit Stafford to discuss the work, please write, giving full details, to Central Personnel Services, Marconi House, 336/7, Strand, London, W.C.2, quoting reference E1295H.

E7513 A

DRAUGHTSMEN

U.K.A.E.A.

RESEARCH GROUP

Opportunities to enter the atomic energy field exist at the Atomic Energy Research Establishment, Harwell, and at the A.E.A. Unit, Bracknell (Berks) for draughtsmen (mechanical, electronic and particularly electrical) with an engineering apprenticeship, two year's drawing-office experience *and* O.N.C.

Salary up to £895. Housing, superannuation and further education schemes. Good prospects.

Please send a POST CARD for details to the Group Recruitment Officer (5062/25), A.E.R.E., Harwell, Berks.

E7507 A

NORRIS CONSULTANTS LTD.,

in view of a two-year expansion programme, require for their London and Bristol Offices and elsewhere in the U.K., Senior and Junior Engineers, Designers and Draughtsmen in the following fields.

CIVIL ENGINEERING AND SERVICES DIVISION

Reinforced Concrete, Heating, Ventilating, Air Conditioning, Refrigeration, Pipework and General Services, Structural Steelwork.

PRODUCTION & MECHANICAL DIVISION

Special purpose machines, Transfer Systems, Jigs and Tools, General mechanical, Mechanical Handling, Electrical (Heavy and Light current).

Salary scales up to high level in accordance with age, experience, technical and professional qualifications. Pension and Insurance schemes. Write or telephone Head Office, Beacon House, Queens Road, Clifton, Bristol. Tel. : Bristol 3–6817, or those requiring appointments in London area, write or telephone : 76, Victoria Street, S.W.1. Tel. : VIC 4675.

E7512 A

CENTRAL ELECTRICITY GENERATING BOARD

TRANSMISSION DEPARTMENT

TRANSMISSION CONSTRUCTION BRANCH

at HEADQUARTERS, LONDON, S.E.1.

Due to an increase in the scope of the work of the Branch, applications are invited for the appointment of a number of **SENIOR ASSISTANT CIVIL ENGINEERS** in the Civil Engineering Sub-Branch of the above department.

Candidates should preferably be Corporate Members of one of the recognised Engineering Institutions and/or hold a University Degree in Civil Engineering, and have a wide experience of general civil engineering work.

The duties are concerned with all aspects of the design and construction by contract of the civil engineering and building work required in connection with the establishment or extension of high voltage sub-stations.

Salaries on a scale within the range £1475–£2045 p.a., according to duties and responsibilities.

Applications, stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24/30, Holborn, London, E.C.1, by 23rd October. Envelopes should be marked "Confidential Ref. ENR/395."

E7532 A

WORKS ENGINEER (Refractories)

A Works Engineer (Refractories) is to be appointed who will be responsible to the Chief Engineer for the planning and control of all refractory brick work throughout the Steel Division—the largest integrated steel plant in Europe. This will include the main process departments of coke ovens, blast-furnaces, steel shops and rolling mills. He will be responsible for the control of the bricklayer and associated labour force. In addition, he will be concerned with the development of new types of refractory material and designs to improve furnace performance.

Associate membership of the Institution of Mechanical Engineers is desirable but not so important as extensive technical knowledge and practical experience of refractories.

Please write, giving full details of age, experience, qualifications and any further information considered relevant, to :

Superintendent, Personnel Services,
THE STEEL COMPANY OF WALES LIMITED,
(Steel Division),
Abbey Works, Port Talbot, Glam.

E7550 A

Esso

SENIOR INSTRUMENT ENGINEER

A SENIOR INSTRUMENT ENGINEER is required to take charge of the INSTRUMENT DESIGN AND DEVELOPMENT GROUP at the ESSO REFINERY, FAWLEY.

Responsibilities include :

(*a*) Design and development of instrumentation for Refinery process units ; (*b*) keeping himself informed of all developments in the field of instrumentation ; (*c*) leading a group of instrument engineers and draughtsmen.

Candidates should have :

(*a*) A good Honours Degree in Electrical or Mechanical Engineering, or be Corporate Members of a Senior Engineering Institution ; (*b*) several years' experience of instrumentation on large plants, preferably in the oil refining industry ; (*c*) experience of supervising a group of graduate engineers.

The starting salary will be in accordance with age and experience. Rented accommodation may be provided if required. There is an excellent pension scheme and first-class recreational facilities are available.

Applications should be addressed to :

The Employee Relations Superintendent,
ESSO PETROLEUM COMPANY LIMITED,
Esso Refinery,
Fawley, Nr. Southampton

E7539 A

AEI

MACHINE SHOP SUPERINTENDENT

required by large British-owned Electrical Engineering Factory in India. Applicants should be between ages of 30 and 40 years and have served a machine shop craft apprenticeship with subsequent experience in machining medium-sized products on a batch production basis. Applicants should have risen to foreman or potential foreman status and be able to demonstrate setting up and operating of machine tools and train labour. Experience of blanking presses, electro-plating and light Non-ferrous casting desirable but not essential. The appointment, which is a senior one, would be for 3 years in the first instance with passage, accommodation, medical expenses for self and family provided free. The gross salary before tax would be in the range of 1800 to 2250 rupees per month, depending on age and experience. The appointment is pensionable.

Replies, which will be treated in confidence, with names of references to :—

The Secretary, A.E.I. Overseas Ltd.,
33, Grosvenor Place, S.W.1.

E7547 A

SITUATIONS VACANT

PLANT ENGINEERING

(Electrical)

A major manufacturing organisation of international repute requires a well-qualified and experienced Electrical Engineer who must be competent to advise and direct on all problems associated with plant wide distribution of a loading of 20,000 K.W.H.

The vacancy, which is at its largest establishment, bordering on the Home Counties, is intended to strengthen and to provide succession within the Plant Engineering Department. Salary will be commensurate with experience and the post offers considerable opportunity for promotion.

Applications, with full curriculum vitæ including details of salaries earned, may be made in strict confidence to Box No. 2905, c/o Charles Barker and Sons, Ltd., Gateway House, London, E.C.4.

E7560 A

SITUATIONS VACANT

WORK STUDY ENGINEER

required by

W. H. ALLEN SONS & CO., LTD.,

to join the Work Study Section at their

PERSHORE WORKS

Candidates should have a sound engineering training with experience in work measurement and deriving synthetic times for costing and incentive schemes.

Good conditions of employment with contributory pension and life assurance schemes.

Write in confidence stating experience and qualifications, to

THE PERSONNEL MANAGER, ATLAS WORKS, PERSHORE, WORCS.

E7546 A

SITUATIONS VACANT

HEAT TRANSFER AND ELECTROMAGNETIC STUDIES

ENGLISH ELECTRIC, STAFFORD

The Company wishes to appoint two engineers interested in these particular aspects of rotating electrical machines. The work is of a high grade, involving a considerable personal contribution in new ideas and initiative in the development field. Applicants should therefore be well qualified mechanical or electrical engineers with a keen interest in one of these studies.

If you would like to visit Stafford to discuss these openings, please write, giving full details, to Central Personnel Services, Marconi House, 336/7, Strand, London, W.C.2, quoting reference E1218J.

E7514 A

EXPERIMENTAL AND ENGINEERING STAFF

required

for work on Specialised Telemetry Systems

To join a team responsible for the design, installation and operation of ground stations for specialised types of telemetry systems. This work will involve some overseas service.

Qualifications required are :—

Experimental Class. A pass degree or H.N.C. is preferred but the minimum qualification is G.C.E. with two scientific subjects at " A " Level.

Engineer Class. A.M.I.Mech.E. or A.M.I.E.E. is essential and experience in telemetry or radar techniques is desirable.

SALARY : Experimental Class within the range £1025–£1685.
Engineer Class within the range £845–£1800.

Contributory Superannuation Scheme. A house, or substantial assistance with house purchase, will become available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer at A.W.R.E., Aldermaston, Berks. Please quote ref. 2412/25.

E7506 A

CALTEX SERVICES LIMITED

have vacancies for

CHEMICAL AND MECHANICAL DESIGN ENGINEERS

Applications for these openings, with unique opportunities for career advancement, are invited from men with a University Degree, having had at least two or three years' experience since graduation in design problems related to Petroleum refining or heavy chemical process plant, the upper age limit being 35.

A good salary will be offered for these progressive positions in the field of oil refinery design engineering. Opportunities arise from time to time for transfers to Associated Companies overseas, there being a contributory pension plan, both here and abroad.

Please write under reference " LON," giving full particulars of age, qualifications and experience, to :—

THE MANAGER PERSONNEL,
CALTEX SERVICES, LIMITED,
CALTEX HOUSE,
1, KNIGHTSBRIDGE GREEN,
LONDON, S.W.1.

E7456 A

NABISCO FOODS LIMITED

(formerly The Shredded Wheat Company Limited)

WELWYN GARDEN CITY, HERTS

Invite applications for the position of

MANAGER OF MECHANICAL DEVELOPMENT

Successful applicant will be a fully-qualified Mechanical Engineer, with many years of practical experience of mechanical drawing and design of machinery, including automatic processing, packaging and similar equipment, part of it in a position of responsibility such as project engineer. He will have a real desire to do, and possess considerable inherent natural ability for, original development work, and be capable of organising and directing the work of others, and of collaborating with Production, Engineering and other departments.

The Manager of Mechanical Development will be directly responsible to the Works Director for :

1. Increasing the operating efficiency of existing equipment through mechanical improvements installed and tested in actual production ;
2. Introducing economies through reductions in labour by the development of mechanical equipment.

This position carries commensurate salary, progressive salary grade, excellent amenities, and considerable scope in an expanding organisation.

Applicants invited to write, in strict confidence, stating age, educational background, experience, present position and salary, to Executive Administrator—Personnel.

E7515 A

COMMERCIAL DEVELOPMENT ENGINEER

For a Company in Sheffield of Forgemasters and manipulators of steel and non-ferrous metals, responsible to the Commercial Director. This appointment will be of considerable interest to a young man of approximately 30 to 35 who has a flair for seeing the commercial implications and possibilities of Engineering facts and situations. Starting salary will be up to £1400 per annum and related to age and experience. Opportunities for advancement in this field are considerable.

Main duties will be to maintain close contact with the Technical Departments of Industrial Research/Trade organisations so as to obtain information of trends in design and manufacturing method and recommend on the commercial implications of these to the company ; to encourage change in manufacturing method and design so as to utilise company capacity ; to undertake negotiation of contracts up to draft stage.

Essential qualifications are a wide experience of metal working machinery and tools and of metals under conditions of manipulation, together with broad understanding of methods of metal manipulation. A sound understanding of current commercial practices and conditions of sales is also required. Education to H.N.C. Mechanical essential, but an arts degree or B.Sc. Eng. or A.M.I.Mech.E. preferred. Please write briefly in first instance quoting reference No. 248 to :

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1
retained to advise on this appointment

The strictest confidence will be observed and no details of candidates will be passed to clients without candidates' permission.

E7569 A

ENGINEER

B.P. has a vacancy at its Head Office in London for an ENGINEER who will be employed in the Planning Division. Applicants, aged about 30, should hold a good degree in Engineering or be an A.M.I. Mech.E. Practical experience in the automotive and/or diesel engineering field desirable. The work is of a technical/administrative nature, concerned mainly with assessing trends in forward quality of all types of petroleum products and the supply implications. Non-contributory Pension Fund, Housing Scheme. Removal expenses paid in certain cases. Luncheon Club.—Write, giving full details of experience, qualifications, quoting H.4842, to Box 6136, c/o 191, Gresham House, E.C.2.

E7537 A

BUSINESS OPPORTUNITIES

REMPLOY SPONSORSHIP SCHEME.—Send for details which show an attractive proposition to manufacturers.—Write to the Managing Director, Remploy, Ltd., 25–28, Buckingham Gate, S.W.1, or telephone VICtoria 6621 (12 lines). E155 o

ADVERTISER, PRIVATE INVESTOR desires to purchase whole or part interest in concern under progressive management making annual net profit of £15/50,000.—BOX No. E163, " The Engineer." o

TO ENGINEERING GROUPS.—Ultra Modern Foundry producing HIGH-GRADE GREY IRON CASTINGS, capacity 200 tons weekly. Would consider amalgamation and/or co-operation. Asset value of freeholds and plant approximately £150,000/£200,000.—BOX No. E165, " The Engineer." o

PATENTS

THE PROPRIETOR of British Patent No. 590,586, entitled " IMPROVEMENTS IN HYDRAULIC POWER TRANSMISSION MEANS," offers same for Licence or otherwise to ensure its practical working in Great Britain.—Enquiries to Singer, Stern and Carlberg, Chrysler Building, New York, 17, New York, U.S.A. E7495 H

FORD

invite applications for the post of

HEATING AND MECHANICAL DRAUGHTSMAN

Applicants must be capable of preparing schemes for both High and Low Pressure Water Heating systems, Air Conditioning and Boiler House Layout and ancillary equipment. They should be able to work with the minimum of supervision.

H.N.C. or membership of I.V.H.E. is desirable.

Please write to Mr. H. G. Pearman, Training and Recruitment Department, Ford Motor Company Limited, Dagenham, Essex, quoting reference KHV.

E7508 A

Classified Advts. continued on page 142

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex (Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

AGENCIES

ENERGETIC, WELL-INTRODUCED ENGINEERING AGENTS required for Company specialised in flow control equipment in connection with Butterfly Valves and Louvre Dampers, for South Wales and the West, Scotland and Southern England.—Please reply to The D.E.V. Engineering Company, Ltd., 299, Chapeltown Road, Leeds, 7. E2563 D

SALES ENGINEER desires Representation or Agency, London area. Good connection. Industrial Undertakings and Government Departments. Experience of power plant, conveying, power transmission and foundry.—BOX No. E2565, "The Engineer." D

ESTABLISHED ENGINEERING COMPANY specialising in Spray Nozzles requires AGENTS in the Midlands and North, preferably having existing connections with Chemical, Engineering, Steel, Air Conditioning and Associated Industries.—BOX No. E2570, "The Engineer." D

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BELLMANS MASTS FOR HIRE, to lift from 1 to 20 tons, 30ft. to 150ft. Blocks and tackle. Hand-operated winches. From £1 per day.—BELLMAN'S (Phone : SLOane 5259), Hobart House, Grosvenor Place, S.W.1. E103 K

MOBILE LIFTING SERVICES.—Lump sum or Hire Rate Quoted for any Lifting Work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 3235. E168 K

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NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft., and 30ft. wide huts ; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel. : Bexleyheath 305). E113 G

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600

ELECTRICALLY DRIVEN COMPRESSOR SETS FOR USE ON 400/440 VOLTS, 3-PHASE, 50 CYCLES SUPPLY

1000 c.f.m. ALLEY AND MACLELLAN 100 p.s.i.
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246 c.f.m. INGERSOLL RAND 100 p.s.i.
150 c.f.m. REAVELL 100 p.s.i.
Two 100 c.f.m. REAVELL 120 p.s.i.

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SONS AND CO. LTD.
Wood Lane, London, W.12.
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WEBSTER & BENNETT Series DH High Speed Hydraulic control Vertical Turning and Boring Mill ; maximum swing 80in. dia. ; dia. of table 65in. ; 12 speeds, 4·5 to 100 r.p.m. ; rapid traverses. Built 1953.

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EUSton 4681 and 3771. E7511 G

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Four Cylinder and Three Cylinder Locomotives, 44/48 and 33/40 H.P.—For further precise details apply : Appleby-Frodingham Steel Co., Scunthorpe, Lincs. Ref. P/EB. E7522 G

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15 CWT. PNEUMATIC HAMMER by Ross. Had little use.—BOX No. E7427, "The Engineer."

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Fielding 500-ton Vertical Downstroke Hydraulic Press, 42in. by 36in. platens, with pumps and motors.
Fielding 200-ton, ditto, 3ft. stroke, with pumps and motors (5 available).
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Two 73ft. 4in. by 5ft. Kilns or Dryers, with Crofts Reduction Gear and 27 h.p. motor.
Two 26ft. by 4ft. Rotary Cooler or Dryers, with reduction gear and motor.
Available at low prices ex present sites to save cost of bringing into stock.

FRED WATKINS (ENGINEERING), LTD., COLEFORD, GLOS. E151 O

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Hartley and Sugden Gas-Fired Fully Automatic Boiler, 800 lb. evaporation. New 1953, used 18 months only. Fitted Ronald Trist and Drayton controls. Can be inspected Fareham Abattoir.

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2—5-ton capacity, 55ft. 3in. span by Craven Bros.
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Modern design in excellent condition, Cab Control 440/3/50.

For appointment to inspect telephone :

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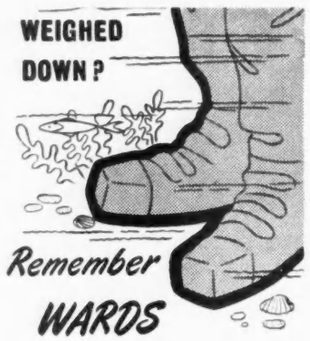
E206 G



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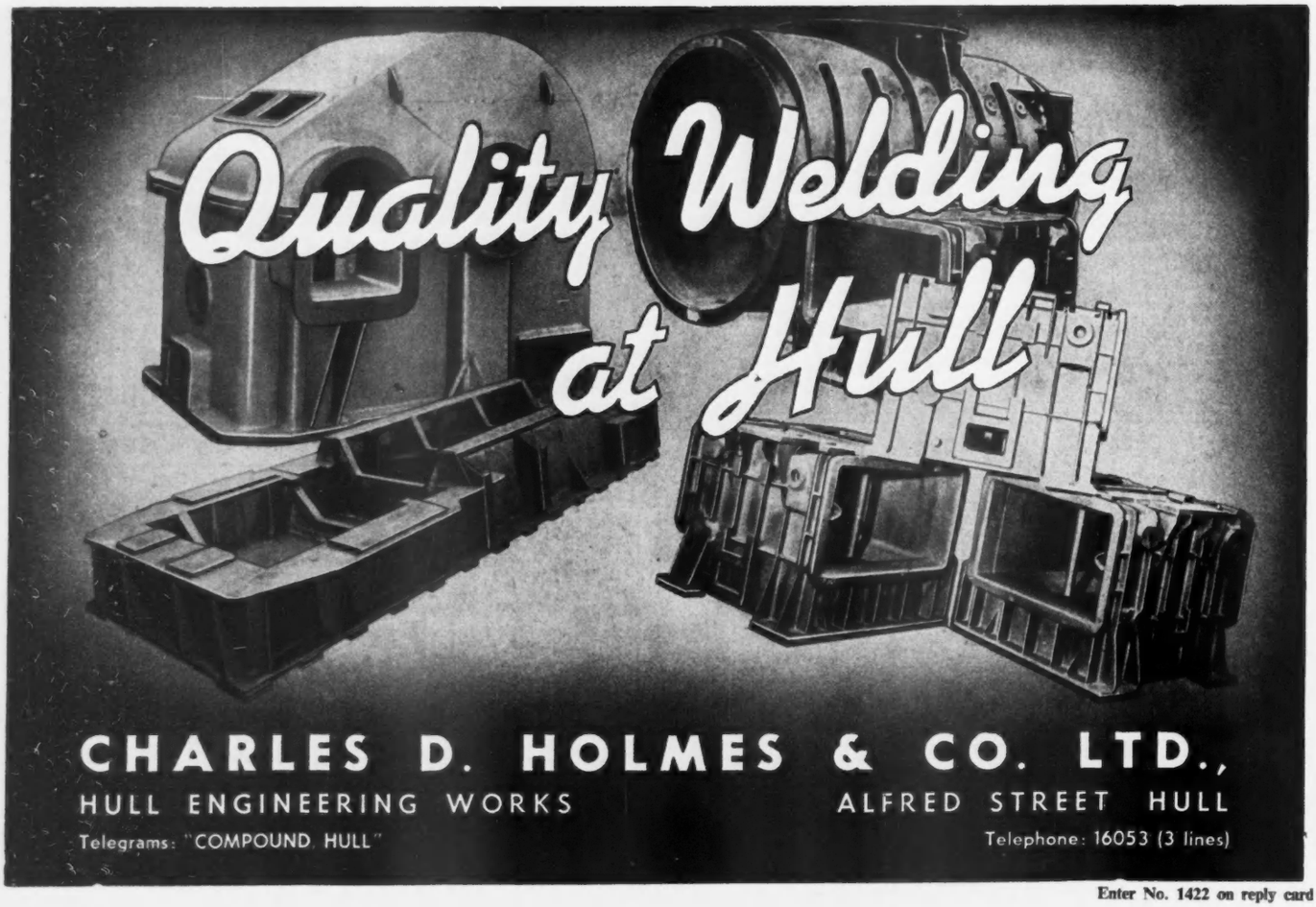

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QUICKWORK No. 321, Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50, capacity 14 S.W.G. mild steel, depth of shear throat 30in., cuts circles from 6in. to 60in. diameter, weight approximately 18 cwt.

JOHN HANDS Double-Sided Friction Screw Press, arranged motor drive, for 400/440/3/50, fitted with Broughton automatic press guard, pressure exerted approximately 60 tons, maximum stroke 18in., between uprights 37½in., tee slotted bed 36in. by 46in.

BLISS No. 1, Double-Sided, Double-Action, Geared Toggle Drawing Press, arranged for belt drive, punch stroke 7in., blankholder stroke 4½in., between uprights 17in., size of bed 16in. by 18½in., hole in bed 6½in. diameter.

NEW BESCO Production Press Brake, Model 125/80, of welded steel plate construction, capacity 80 tons, overall length of bed 126in., width between side frames 97½in., depth of gap in side frames 8in.

NEW BESCO 8ft. 4in. by ⅛in. Type HK, All Steel Undercrank Open-Ended Production Power Guillotine of all steel construction, arranged motor drive for 400/440/3/50, length of blades 110½in., capacity ⅛in., gap in side frames 3½in., strokes per minute 54.

INCANDESCENT Forced Draught Bar Heating Furnace, Double-ended, gas-fitted, heating chamber 36in. wide by 24in. deep by 9in. high, total length through furnace 32in. working, temperature range 900 deg. to 1350 deg. Cent., can be reached in about 1¼ hours after starting from cold.

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600

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BELLISS AND MORCOM surface condenser, 8ft. 6in. long by 3ft. 6in. diam., designed for 8400 lb. exhaust steam per hour, maintaining 26in. vacuum when supplied with 29,000 gallons of cooling water per hour at 75 deg. Fah., complete with water circulating and condensate pump.

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Large numbers of GLASS AND RUBBER-LINED VALVES.
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HYDRAULIC FORMING AND FORGING PRESSES

3000-ton Down-stroke PRESS for HEAVY PLATE FORMING AND BENDING, rams ; admitting 10ft. 6in. between columns ; bed 16ft. by 8ft.
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AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors ; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised ; and several others of various makes and capacities.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p.

MOBILE ROAD CRANES.—10-ton Lorain lorry mounted 30ft.–70ft. extendible jib ; 10-ton 33 R.B. track mounted, 40ft. jib ; 8½-ton Ransomes Diesel/Electric, 21ft. jib ; 6-ton Coles Diesel/Electric, pneumatics, new 1948 (2) ; 6-ton Coles Diesel/Electric, solids ; 4-ton Coles Diesel/Electric, solids ; 1945 ; 4-ton Jones KL44, diesel, 1950 ; 3-ton Jones "Super 40" diesel, pneumatics (3).

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DERRICK CRANES.—7-ton Rushworth, hand, 30ft. jib ; 5-ton Wilson, electric, 70ft. jib ; 1½-ton Anderson Grice, hand, 40ft. jib.

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LOCOS.—Fowler diesel, 150 h.p. (2) ; Bagnall 14in. by 22in., two oil-fired, one coal ; Peckett, steam, 7in. by 12in., 1941 ; also 3 miles track, 24in. gauge, Bogies, Turnouts, &c.

STEEL PIPING.—50,000ft., 2in. Galvanised, new ; 60,000ft. 3in. black, new ; 5000ft., 8in. seamless ; 1000ft., 12in. seamless ; 500ft., 14in. seamless ; 400ft., 18in. riveted ; 2800ft., 21in. o.d. welded flanged ; 3800ft., 21in. seamless flanged ; 500ft., 24in. riveted ; 1450ft., 27in. o.d. welded flanged ; 216ft., 48in. riveted ; 216ft., 60in. riveted.

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STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron tanks to 50,000 gallons.

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October 20-23	Vehicles, earth moving and lifting equipment, including :—	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
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October 23	Clothing and miscellaneous stores.	Command Ordnance Depot, Coypool, Marsh Mills, Plymouth. (Sale at Kinterbury House.)	WOOLLAND, SON & MANICO (Dept. L), Kinterbury House, St. Andrews Cross, Plymouth. (Tel.: 65356.)
October 27-29	Machine tools and miscellaneous stores.	M.O.S. Storage Depot, Royal Arsenal, Woolwich, S.E.18.	FULLER, HORSEY, SONS & CASSELL (Dept. L), 10, Lloyd's Avenue, E.C.3. (Tel.: Royal 4861.)
November 3	Miscellaneous stores.	Command Ordnance Sub-Depot, Devizes. (Sale at Corn Exchange, Devizes.)	FARRANT, WIGHTMAN & PINNIGAR (Dept. L), 2, Newport Street, Swindon, Wilts. (Tel.: 5151/2.)
November 12	Miscellaneous stores.	Central Ordnance Depot, Didcot, Berks.	SIMMONS & SONS (Dept. L), 12, Station Road, Reading, Berks. (Tel.: 54025.)

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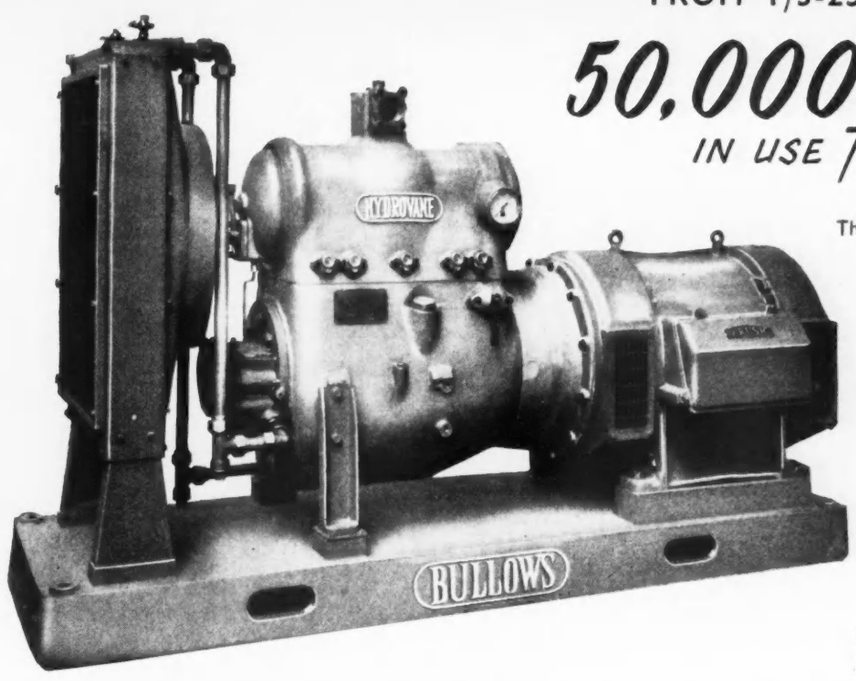

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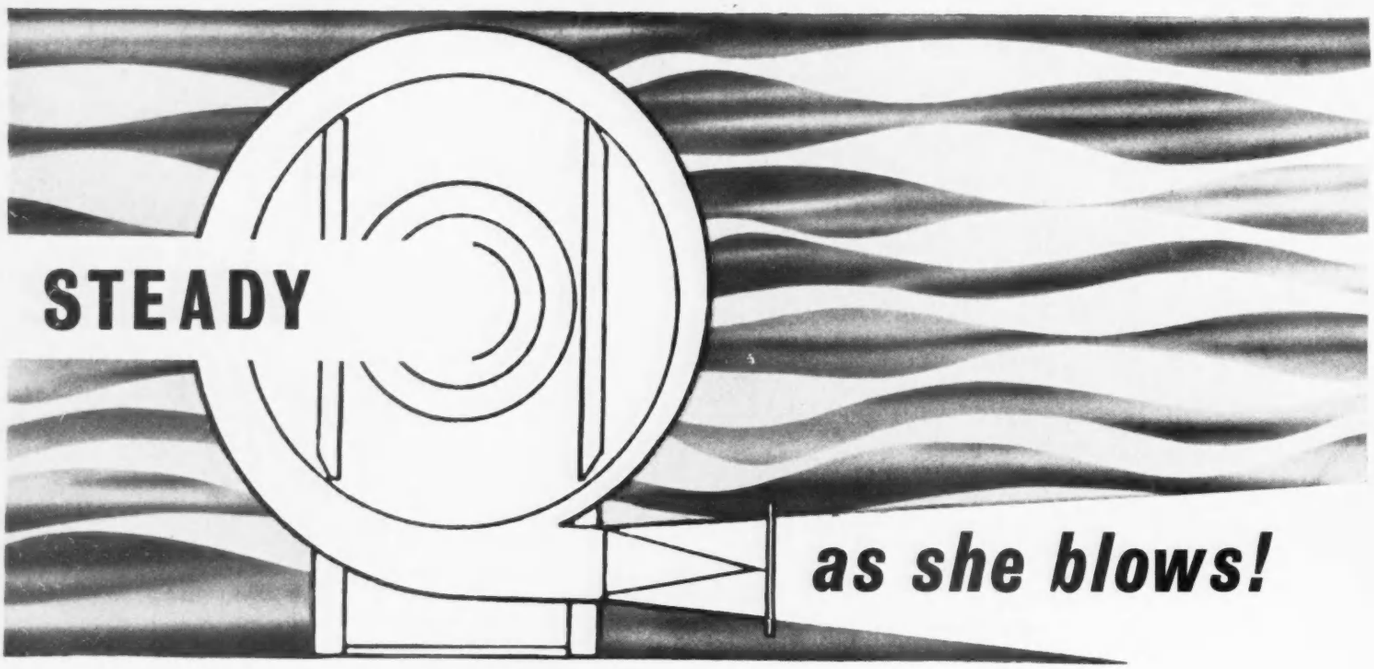

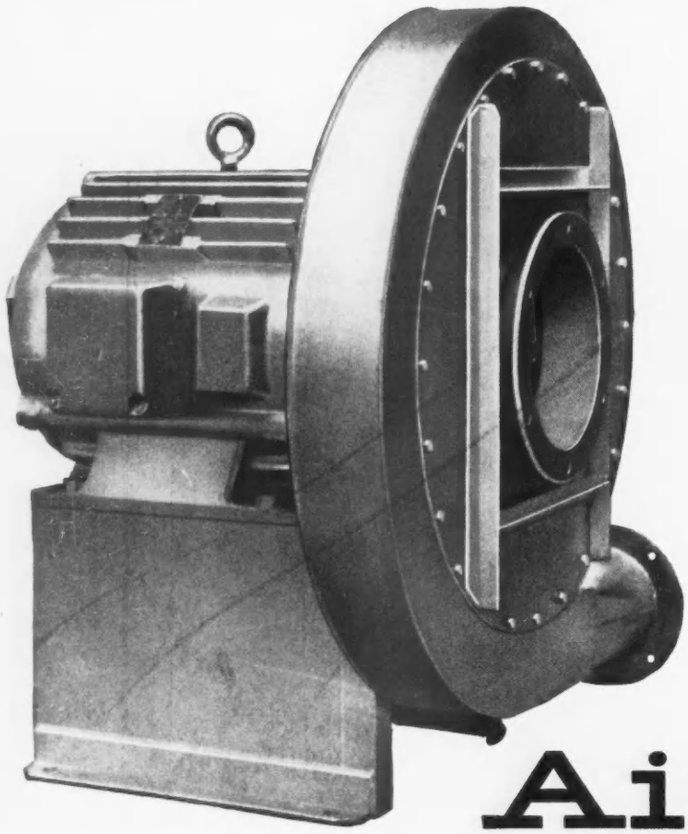

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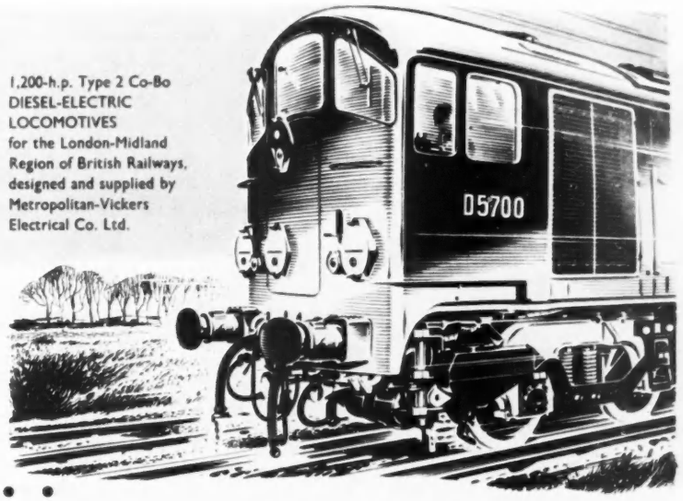

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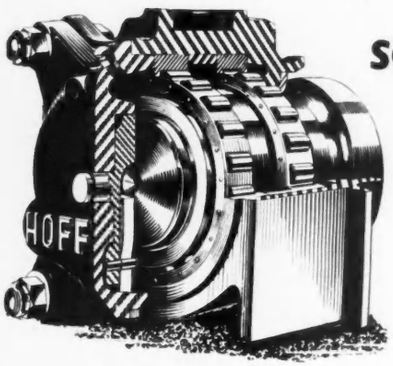

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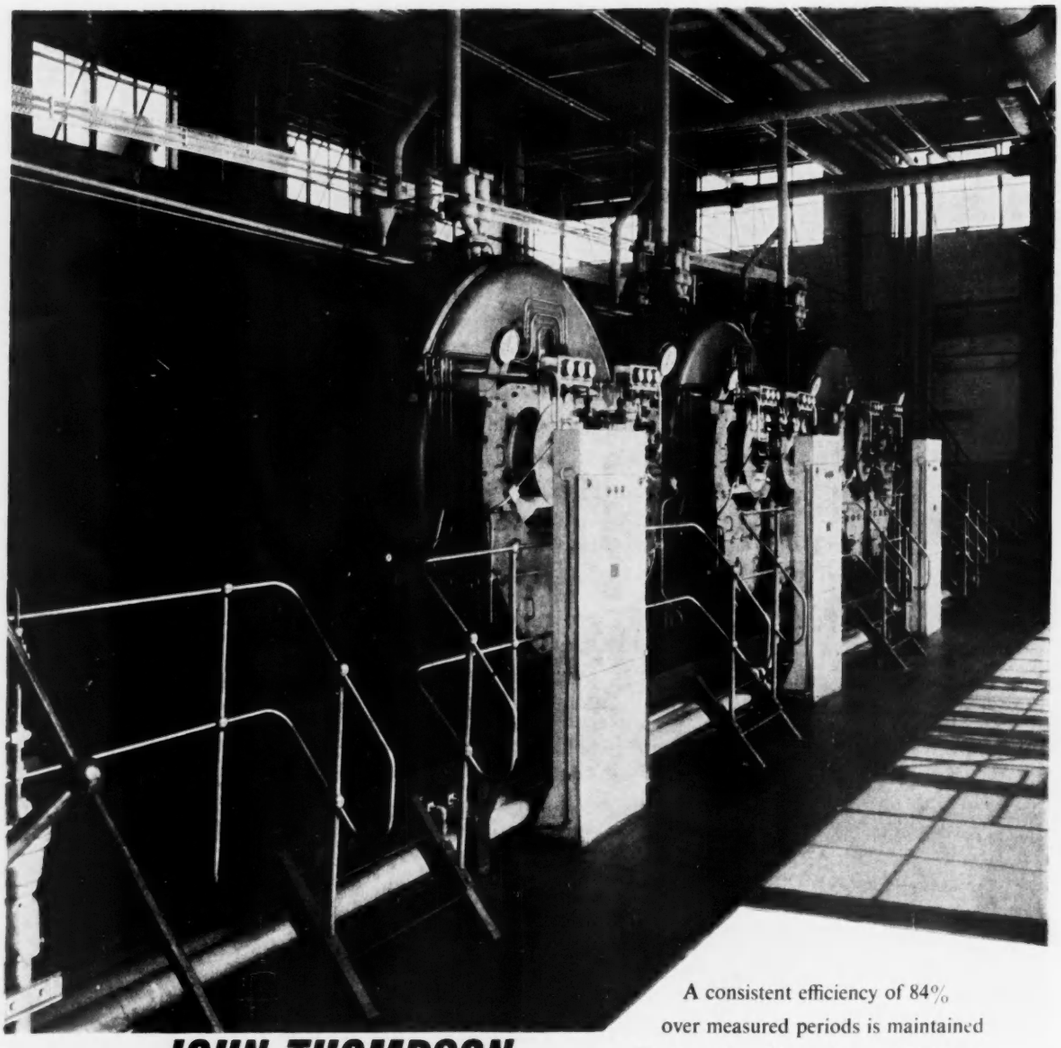

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